Fixed Site NVIS Antennas

Tom Sanders, W6QJI
Ed Bruette, N7NVP

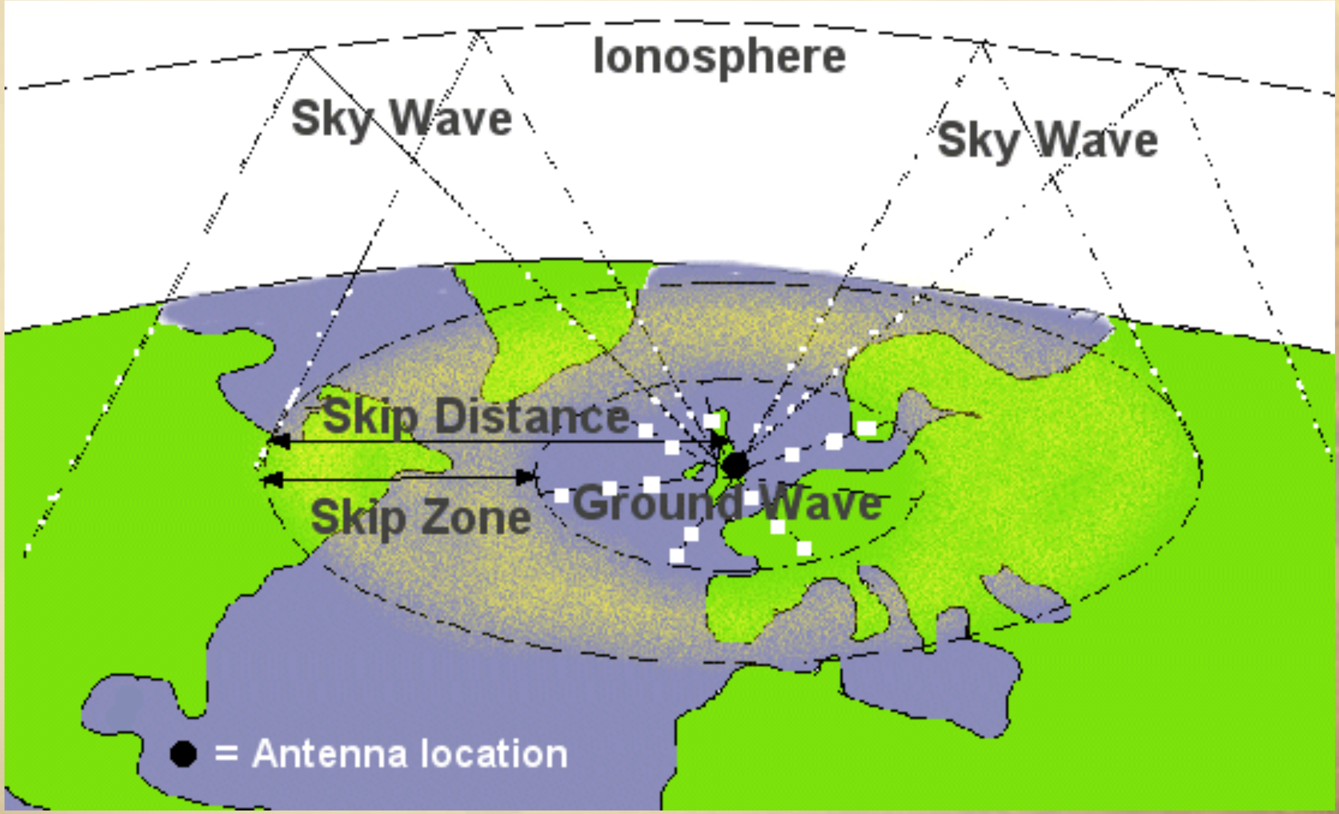
2 April 2005

What is NVIS?

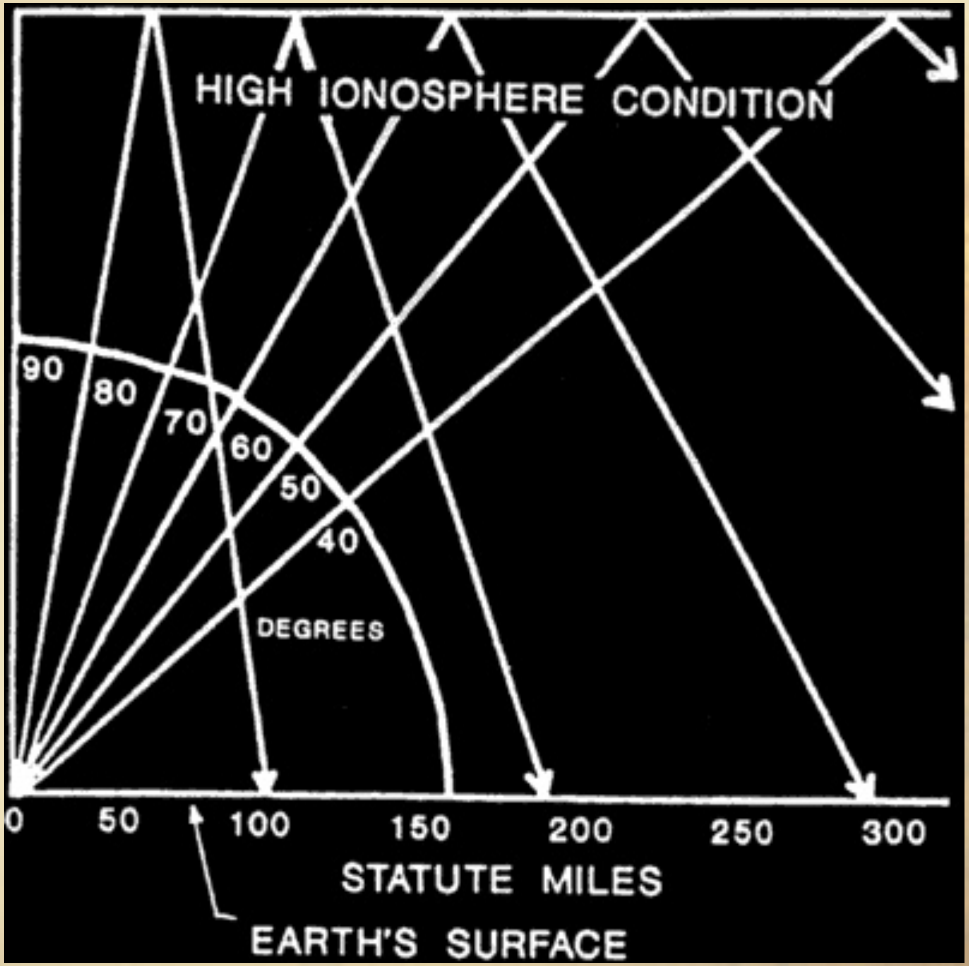
- Near
- Vertical
- Incident
- Skywave

- Cloud Warmer

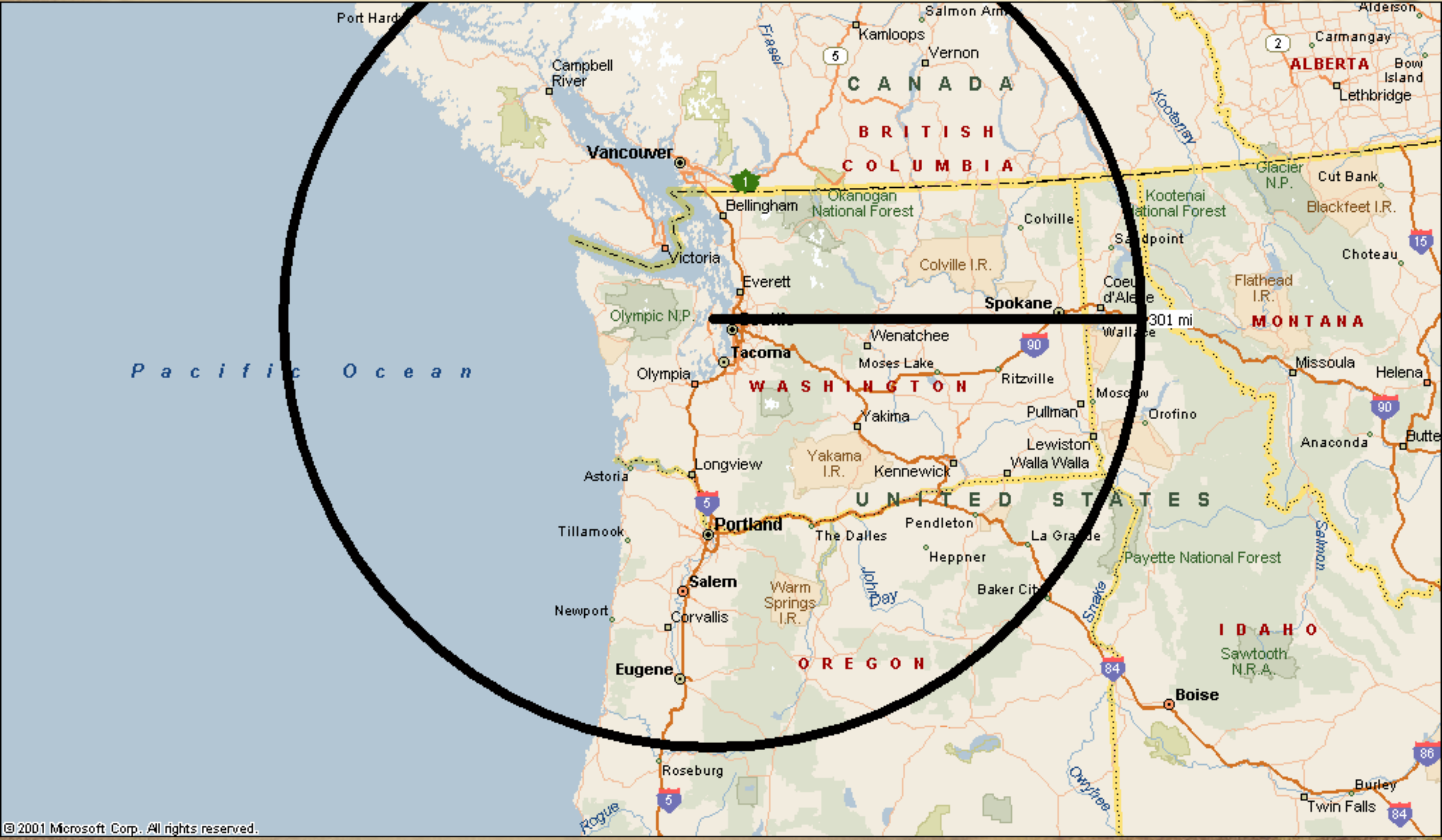
Propagation Theory



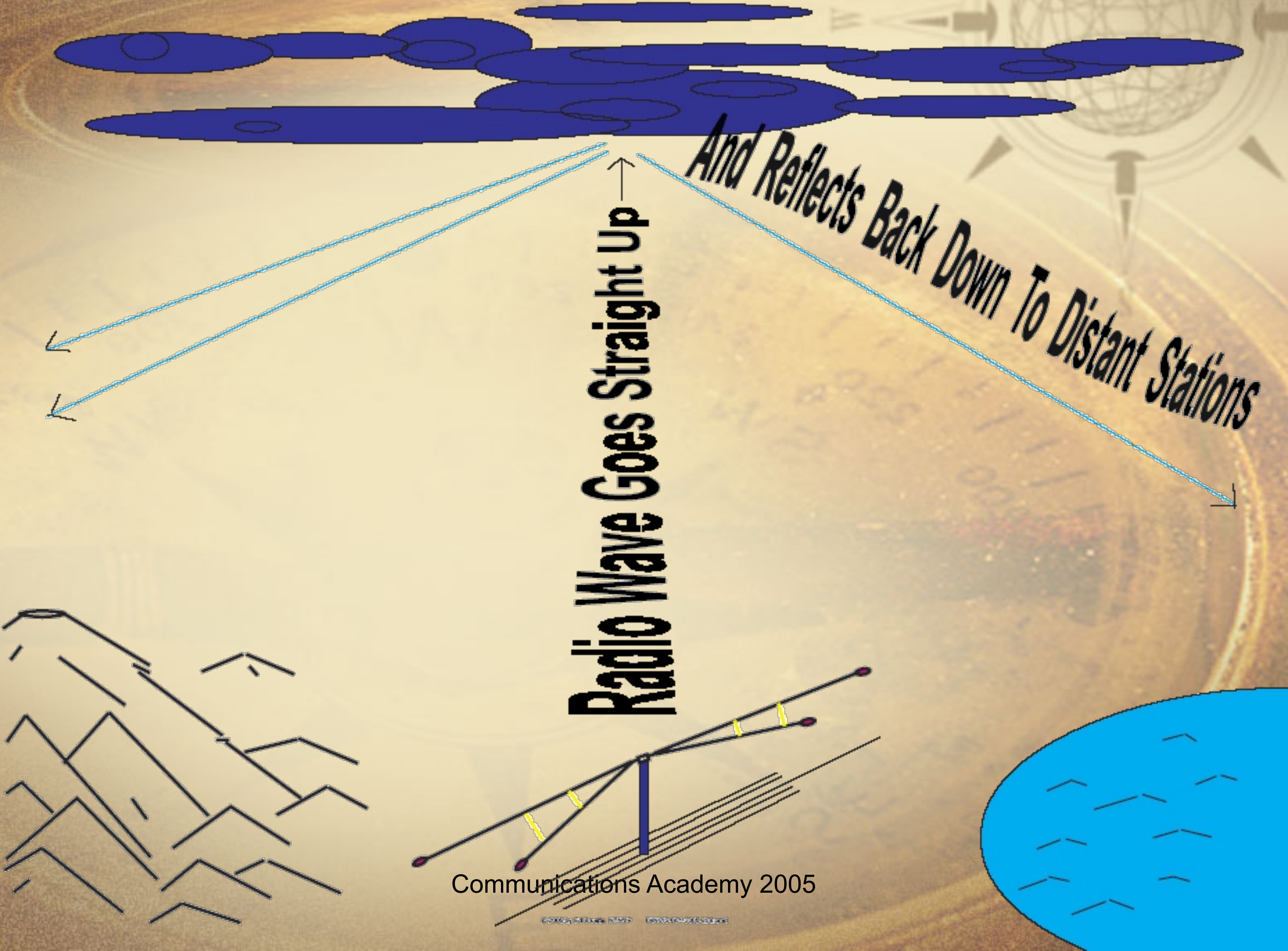
NVIS Effect


HIGH IONOSPHERE CONDITION
DEGREES
STATUTE MILES
EARTH'S SURFACE

300 Mile Coverage

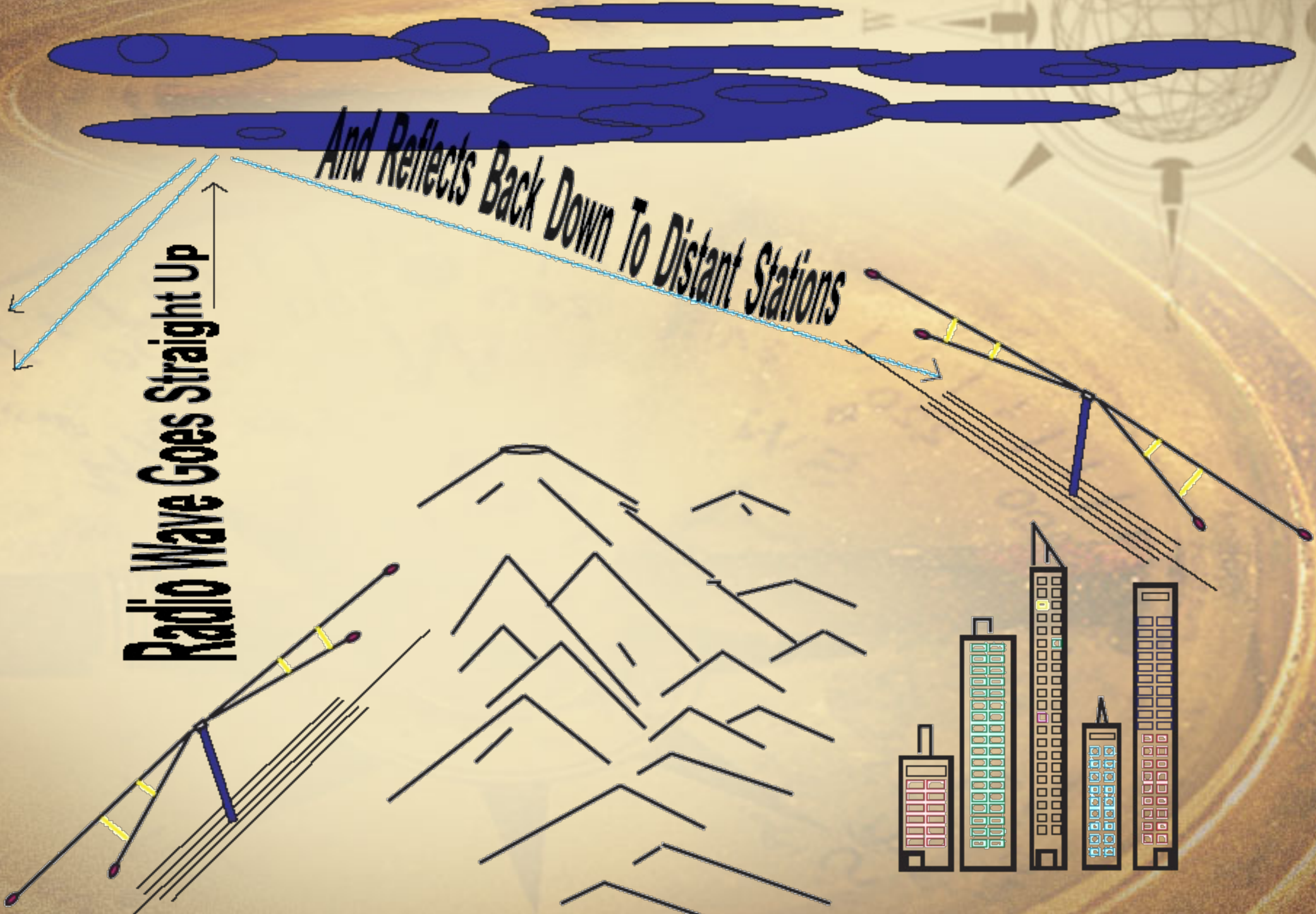


© 2001 Microsoft Corp. All rights reserved.



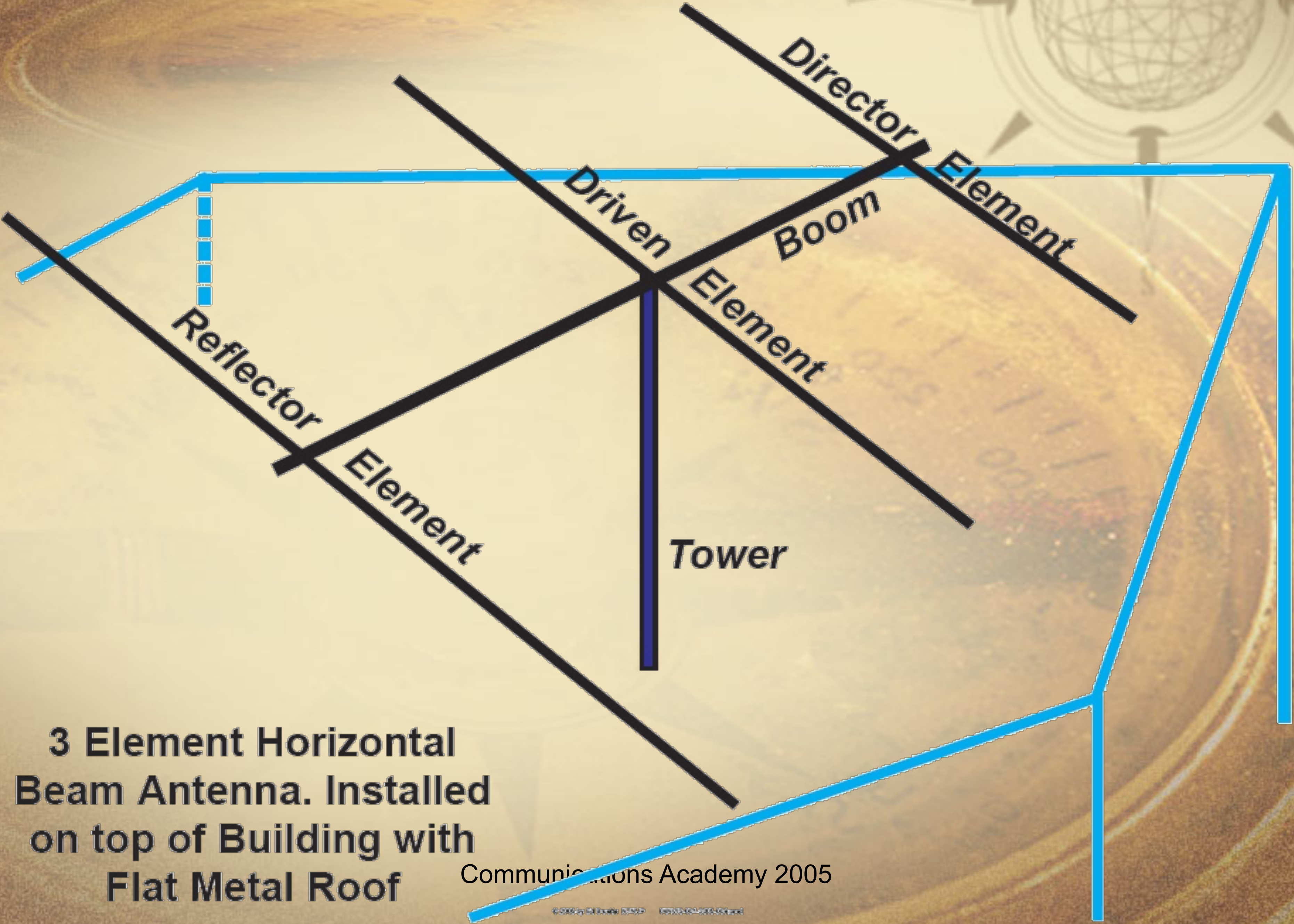
Radio Wave Goes Straight Up

And Reflects Back Down To Distant Stations

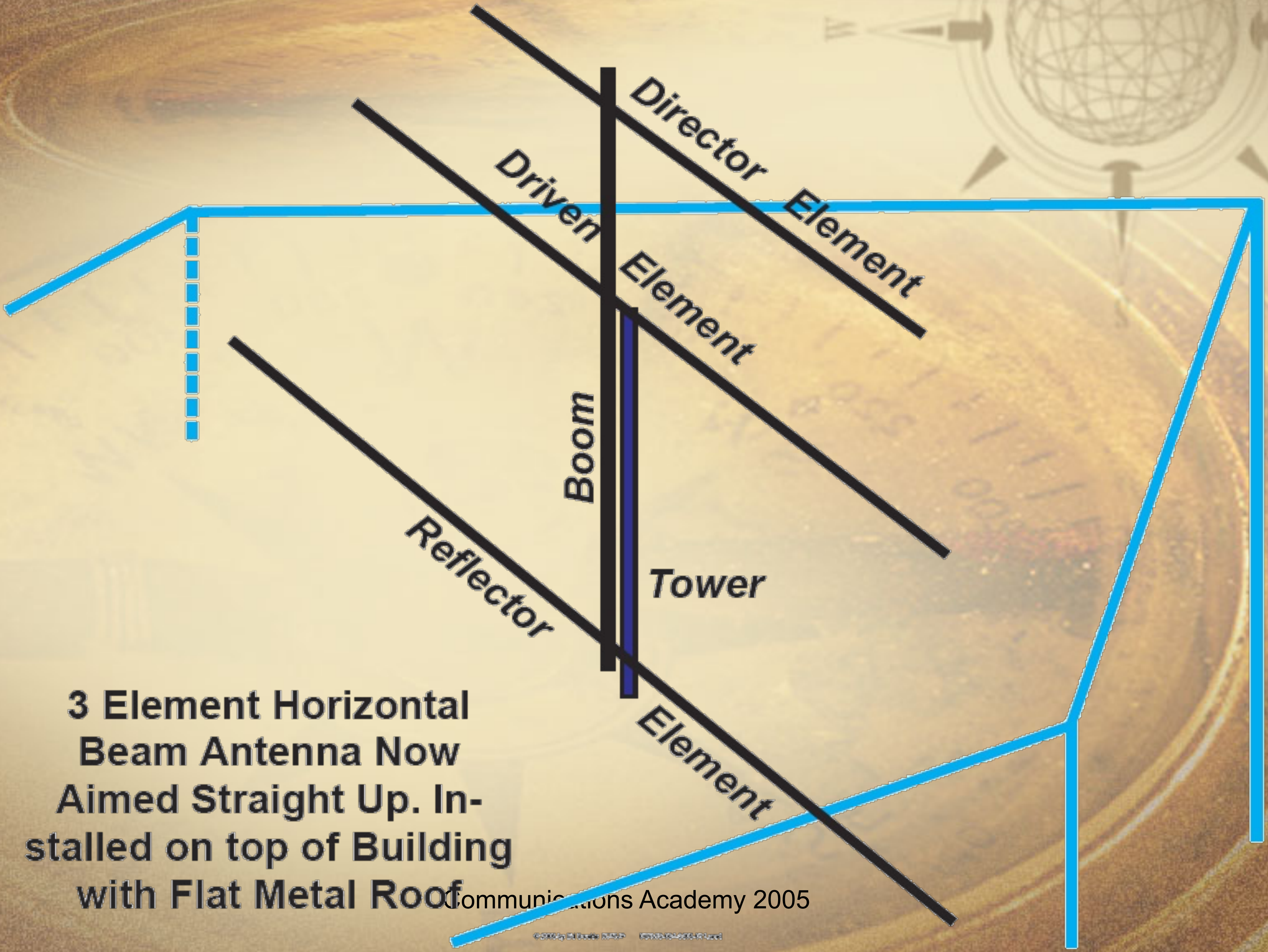


Radio Wave Goes Straight Up

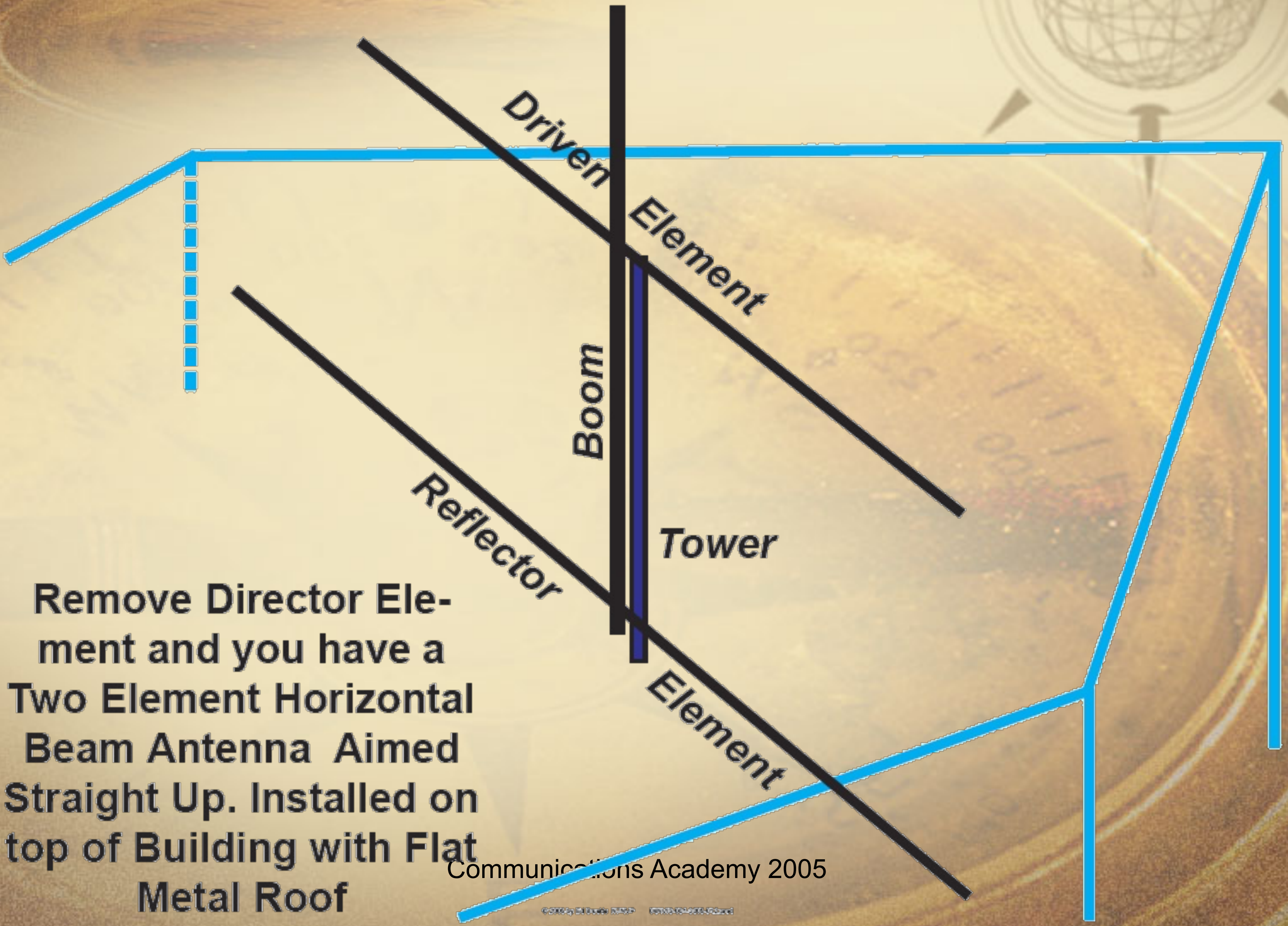
And Reflects Back Down To Distant Stations



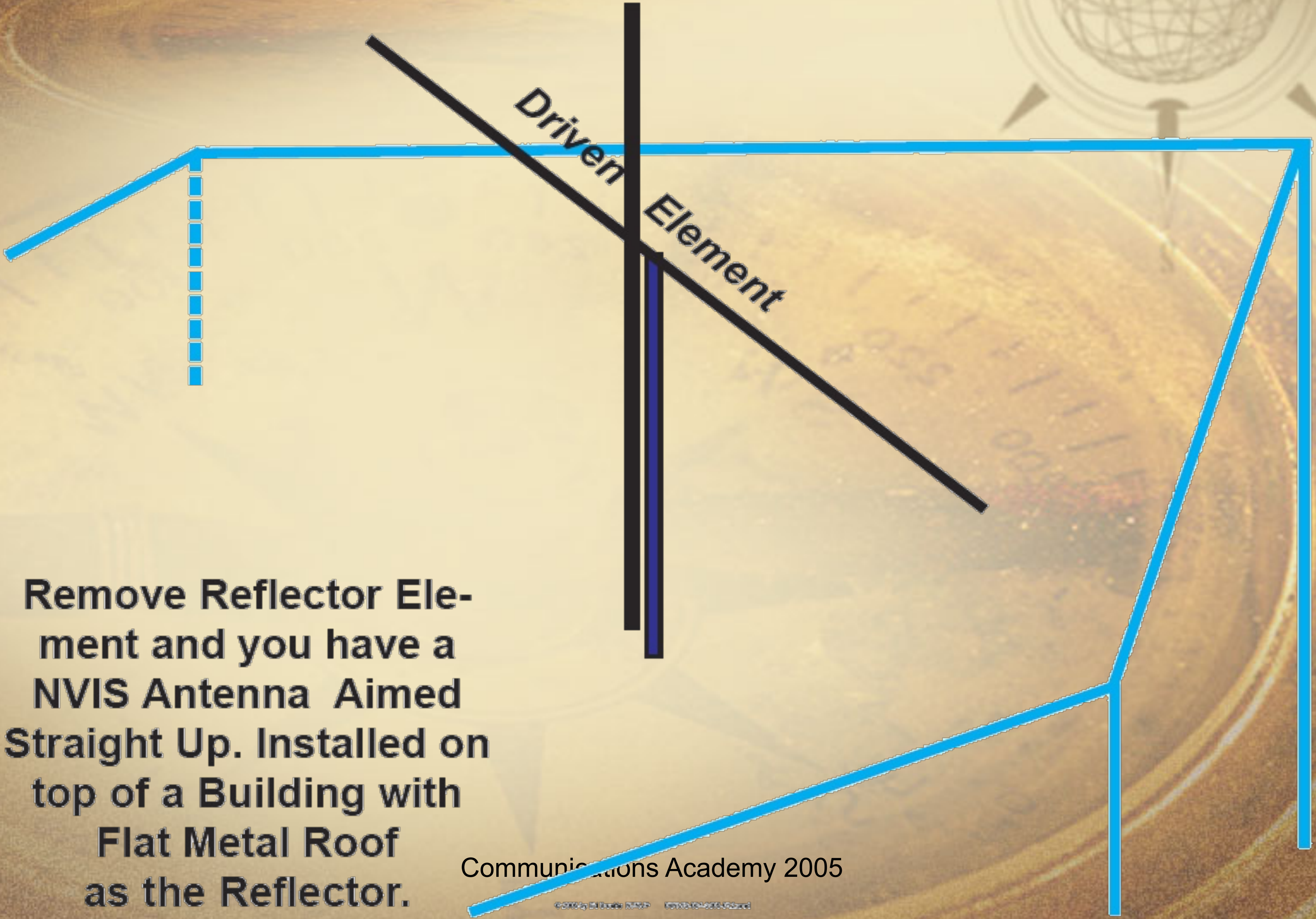
3 Element Horizontal Beam Antenna. Installed on top of Building with Flat Metal Roof



3 Element Horizontal Beam Antenna Now Aimed Straight Up. Installed on top of Building with Flat Metal Roof



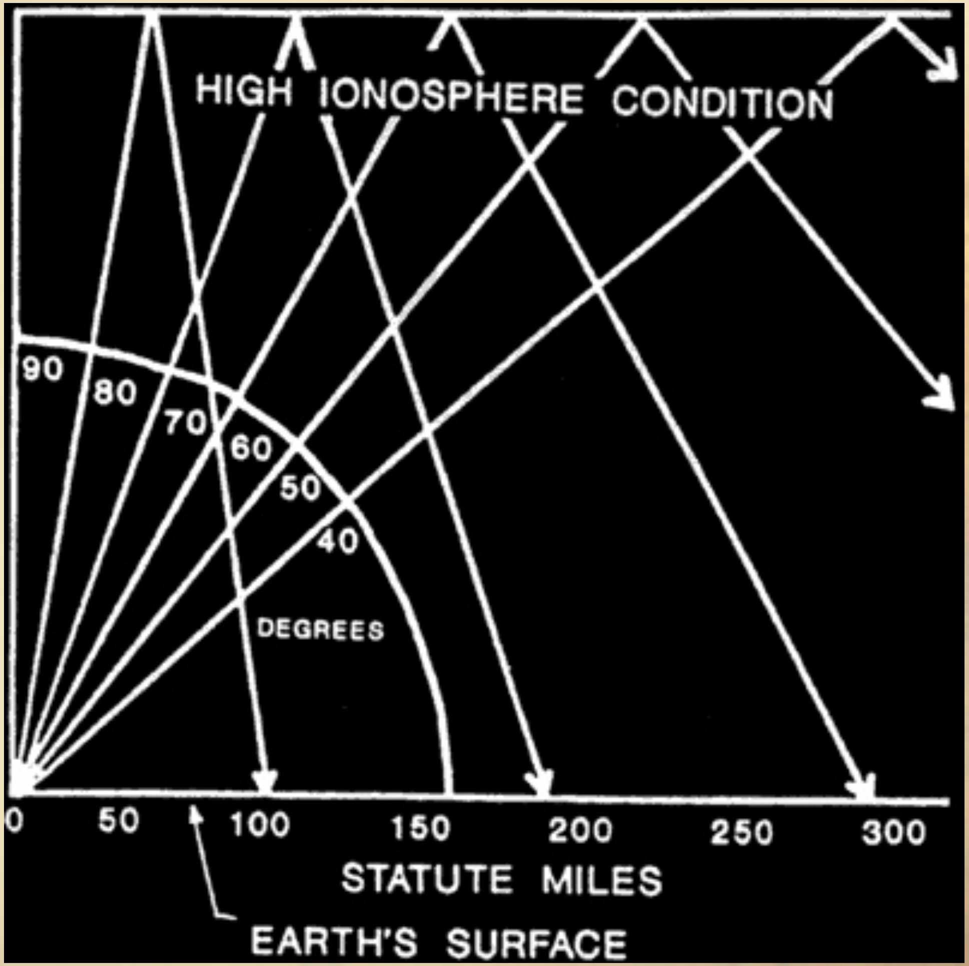
Remove Director Element and you have a Two Element Horizontal Beam Antenna Aimed Straight Up. Installed on top of Building with Flat Metal Roof



Remove Reflector Element and you have a NVIS Antenna Aimed Straight Up. Installed on top of a Building with Flat Metal Roof as the Reflector.

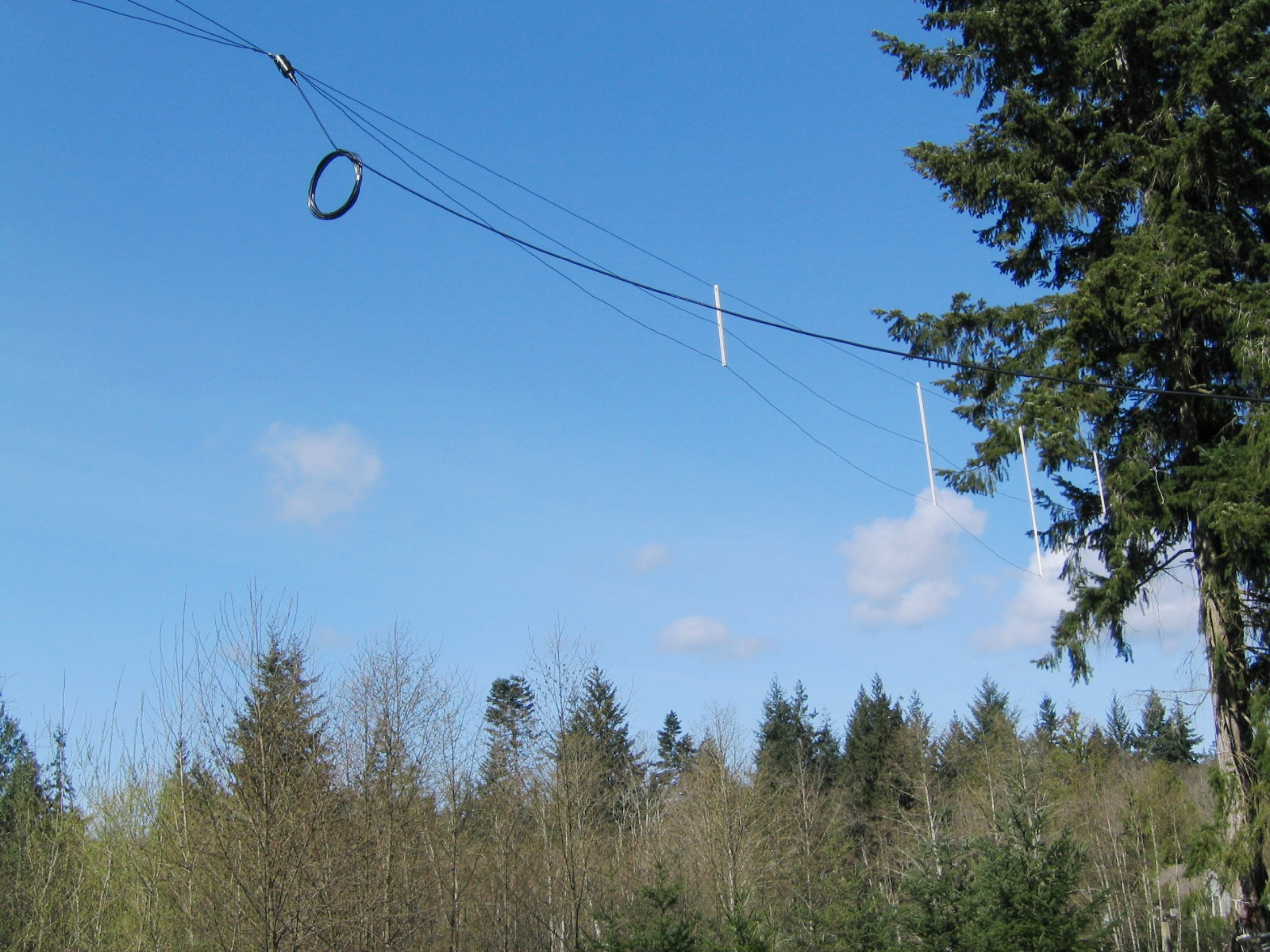
Here’s Tom!

NVIS Effect

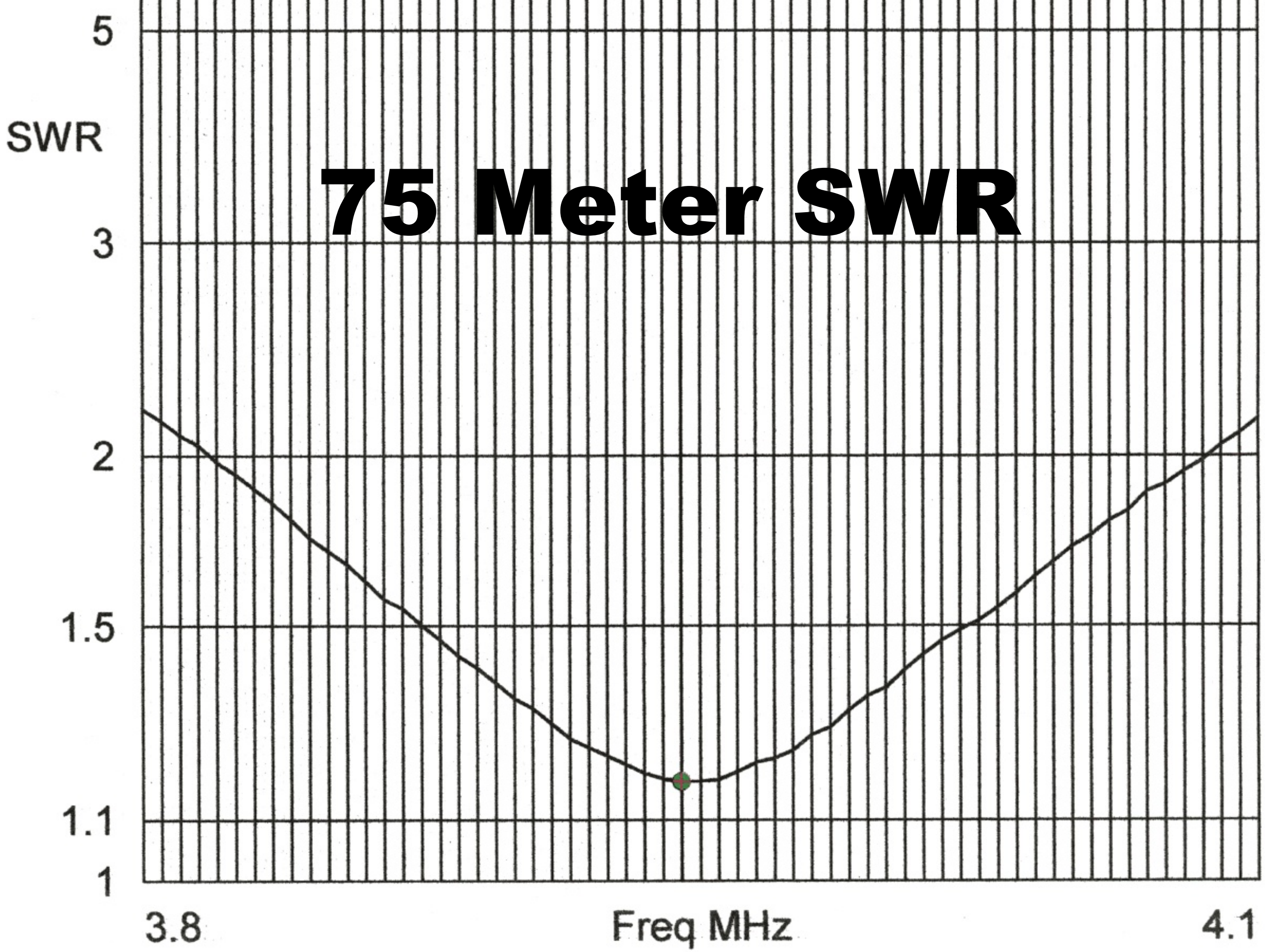

HIGH IONOSPHERE CONDITION
DEGREES
STATUTE MILES
EARTH'S SURFACE

Propagation Considerations

- “D” layer losses
- Ionospheric scattering for vertical propagation
- Importance of critical frequency



75 Meter SWR



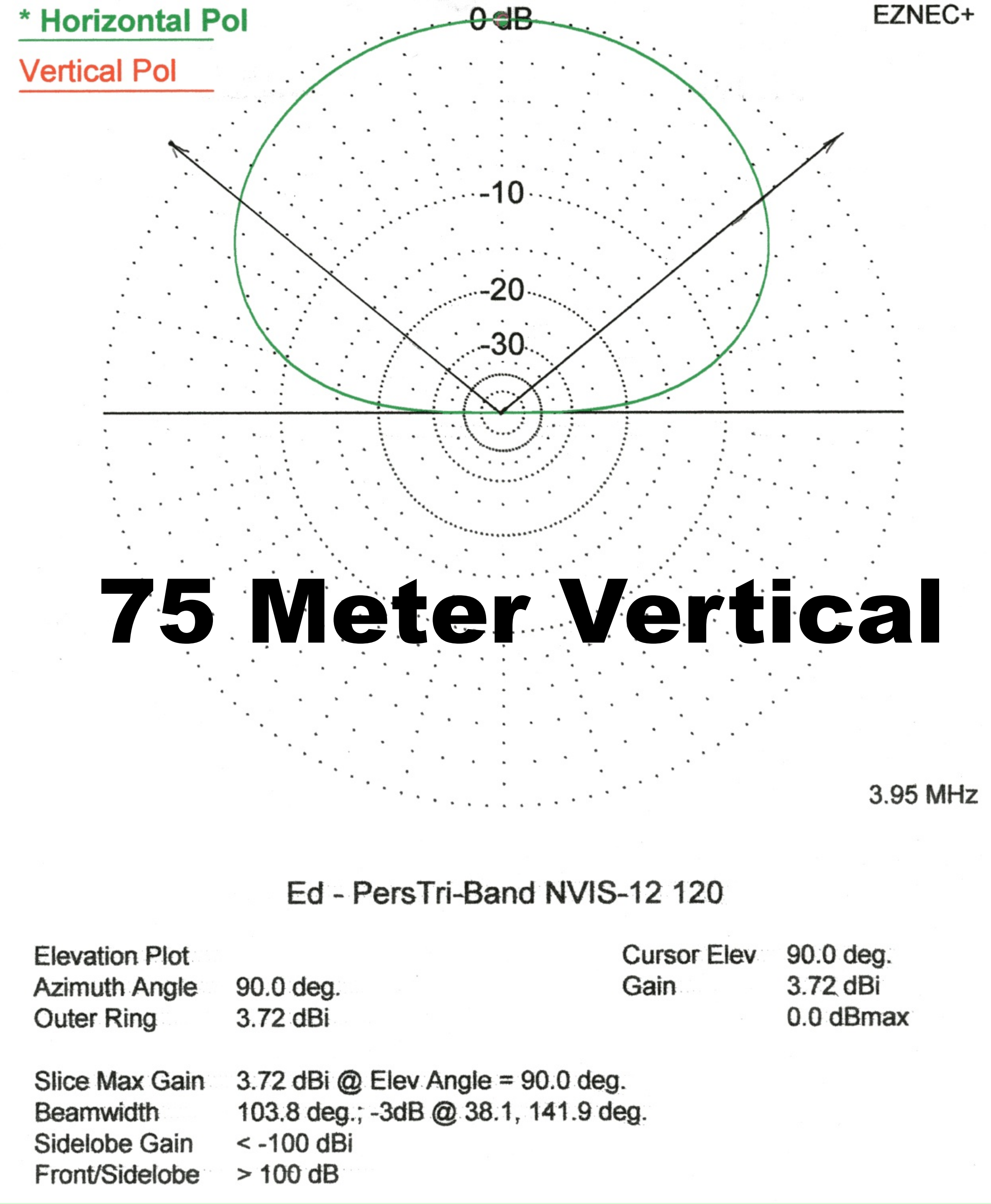
Ed - PersTri-Band NVIS-12 120

Freq	3.945 MHz	Source #	1
SWR	1.17	Z0	50 ohms
Z	42.73 + j 0.2181 ohms		
Refl Coeff	0.07844 at 178.15 deg.		

Bandwidth 75 Meters

- 4005 – 1.5:1
- 3950 – dip
- 3875 – 1.5:1

75 Meter Vertical



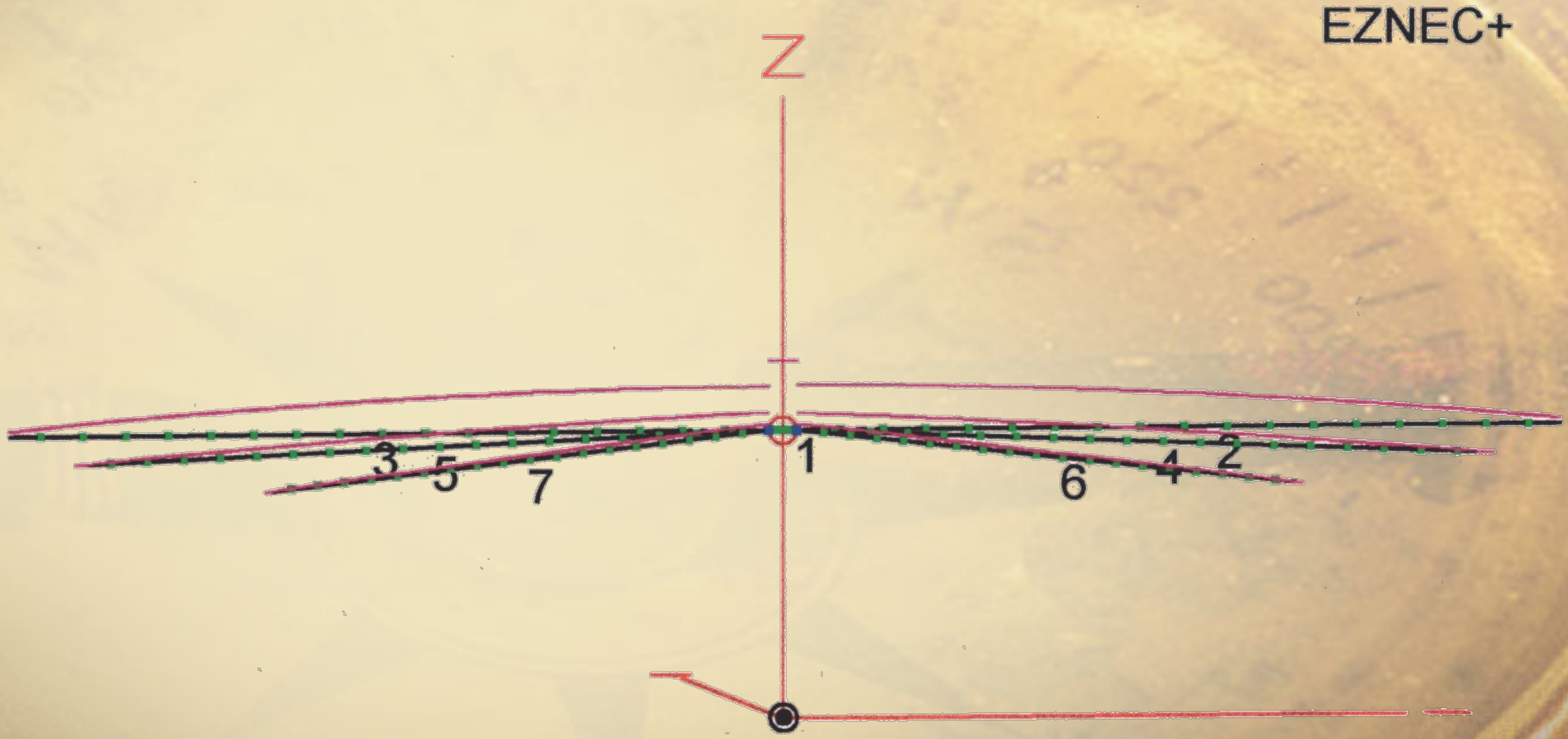
Ed - PersTri-Band NVIS-12 120

Elevation Plot	
Azimuth Angle	90.0 deg.
Outer Ring	3.72 dBi

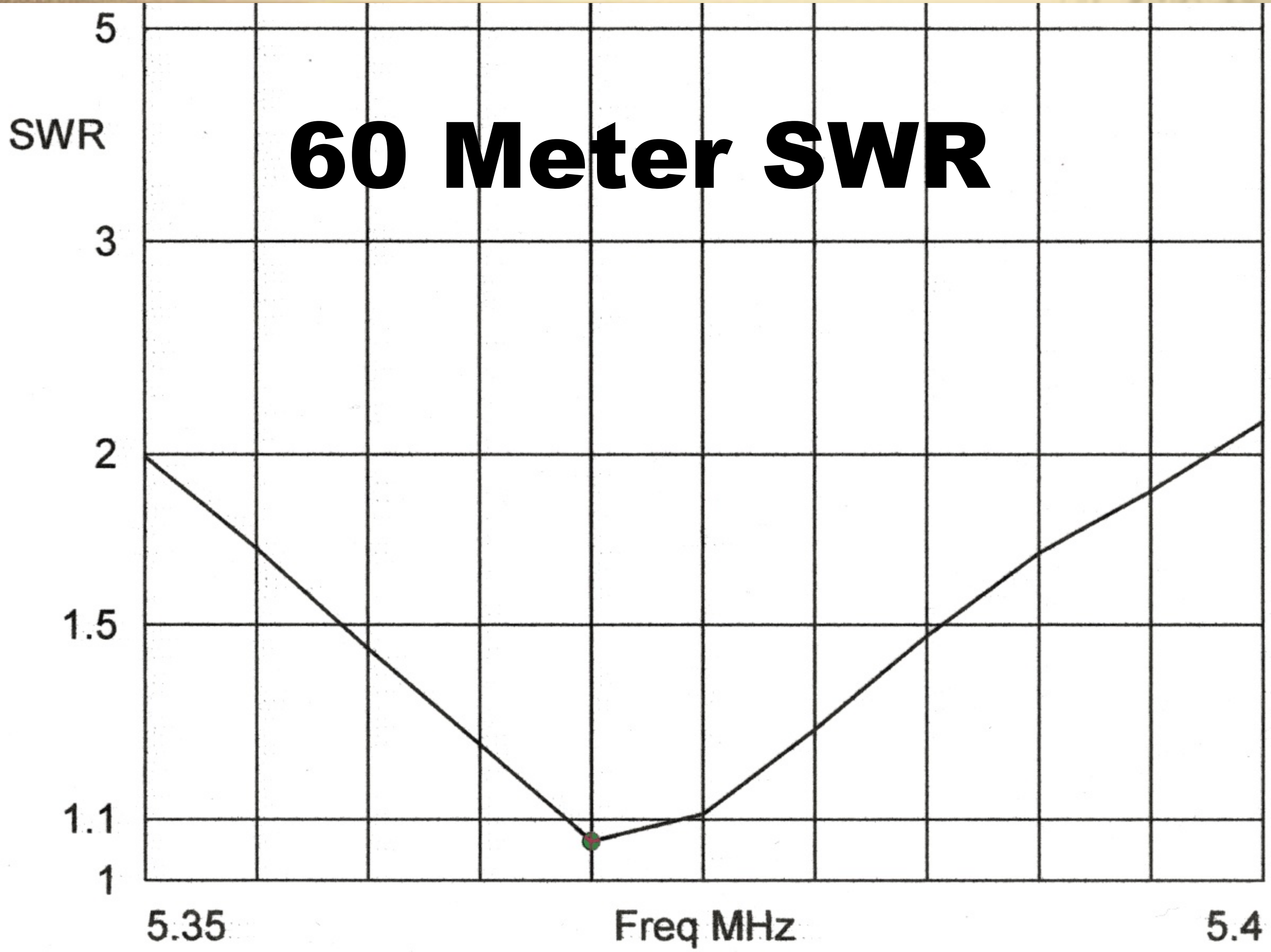
Cursor Elev	90.0 deg.
Gain	3.72 dBi 0.0 dBmax

Slice Max Gain	3.72 dBi @ Elev Angle = 90.0 deg.
Beamwidth	103.8 deg.; -3dB @ 38.1, 141.9 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

75 Meter Current Distribution



60 Meter SWR



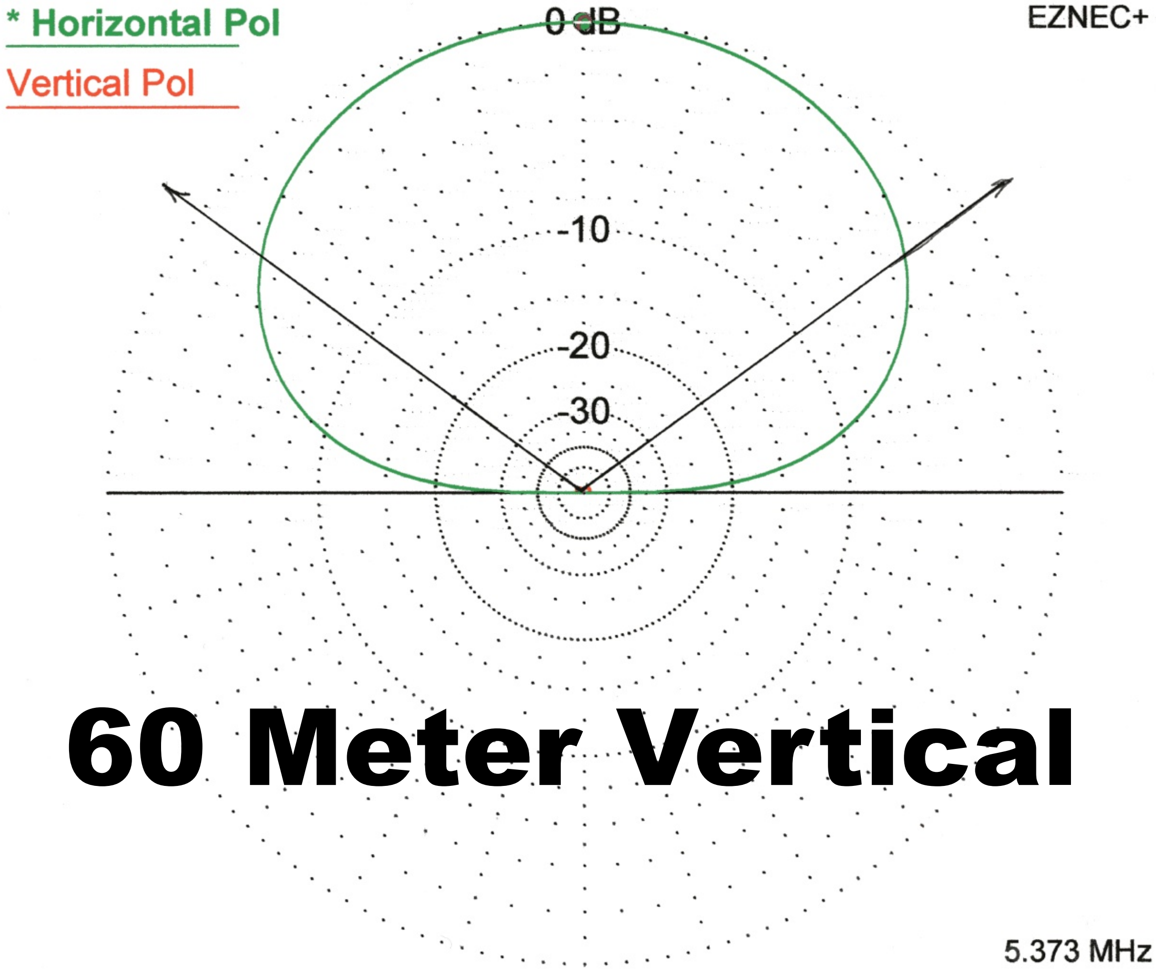
Ed - PersTri-Band NVIS-12 120

```
Freq          5.37 MHz                         Source #    1
SWR           1.064                            Z0          50 ohms
Z             48.07 - j 2.329 ohms
Refl Coeff    0.03085 at -128.34 deg.
```

Bandwidth 60 Meters

- 5390 – 1.5:1
- 5360 – dip
- 5317 – 1.5:1

60 Meter Vertical



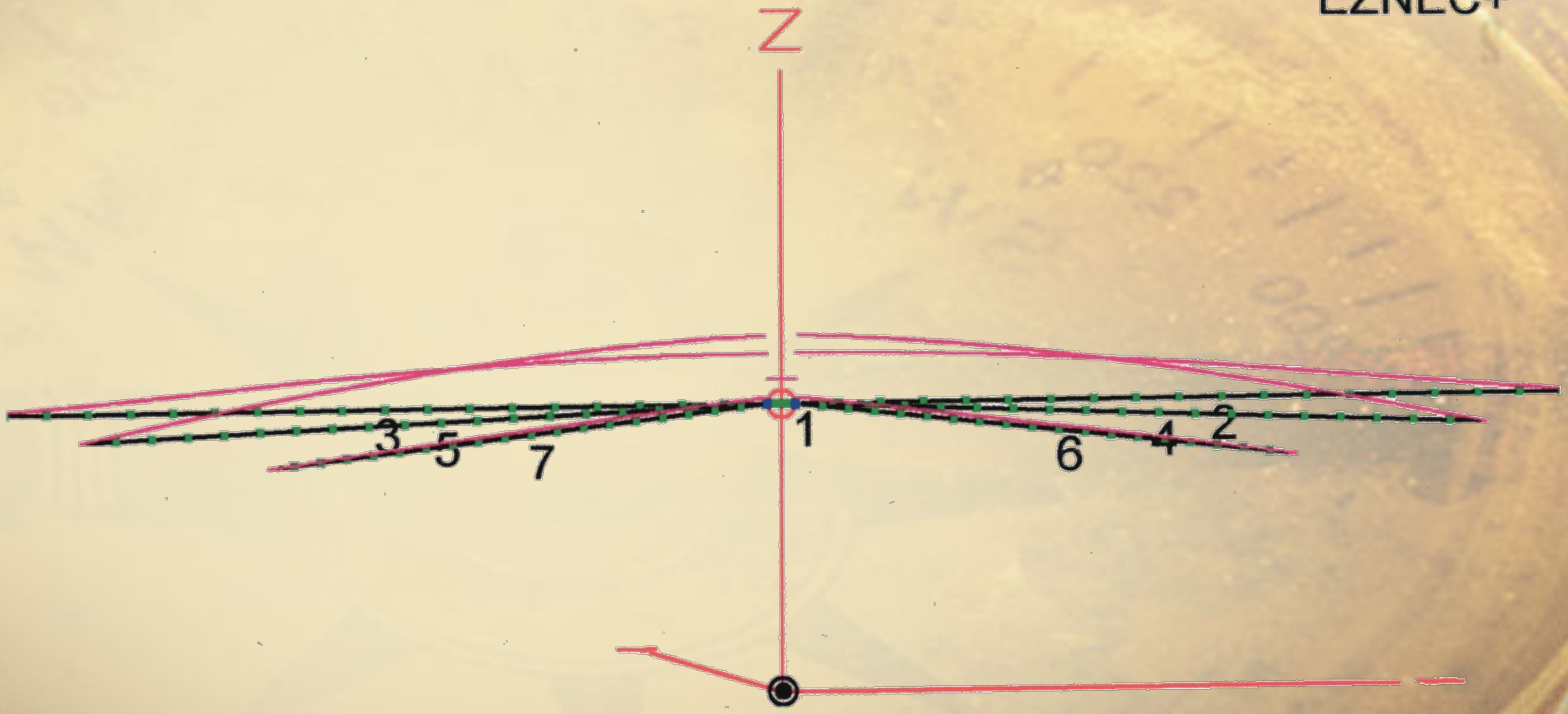
Ed - PersTri-Band NVIS-12 120

Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	90.0 deg.	Gain	2.08 dBi
Outer Ring	2.08 dBi		0.0 dBmax

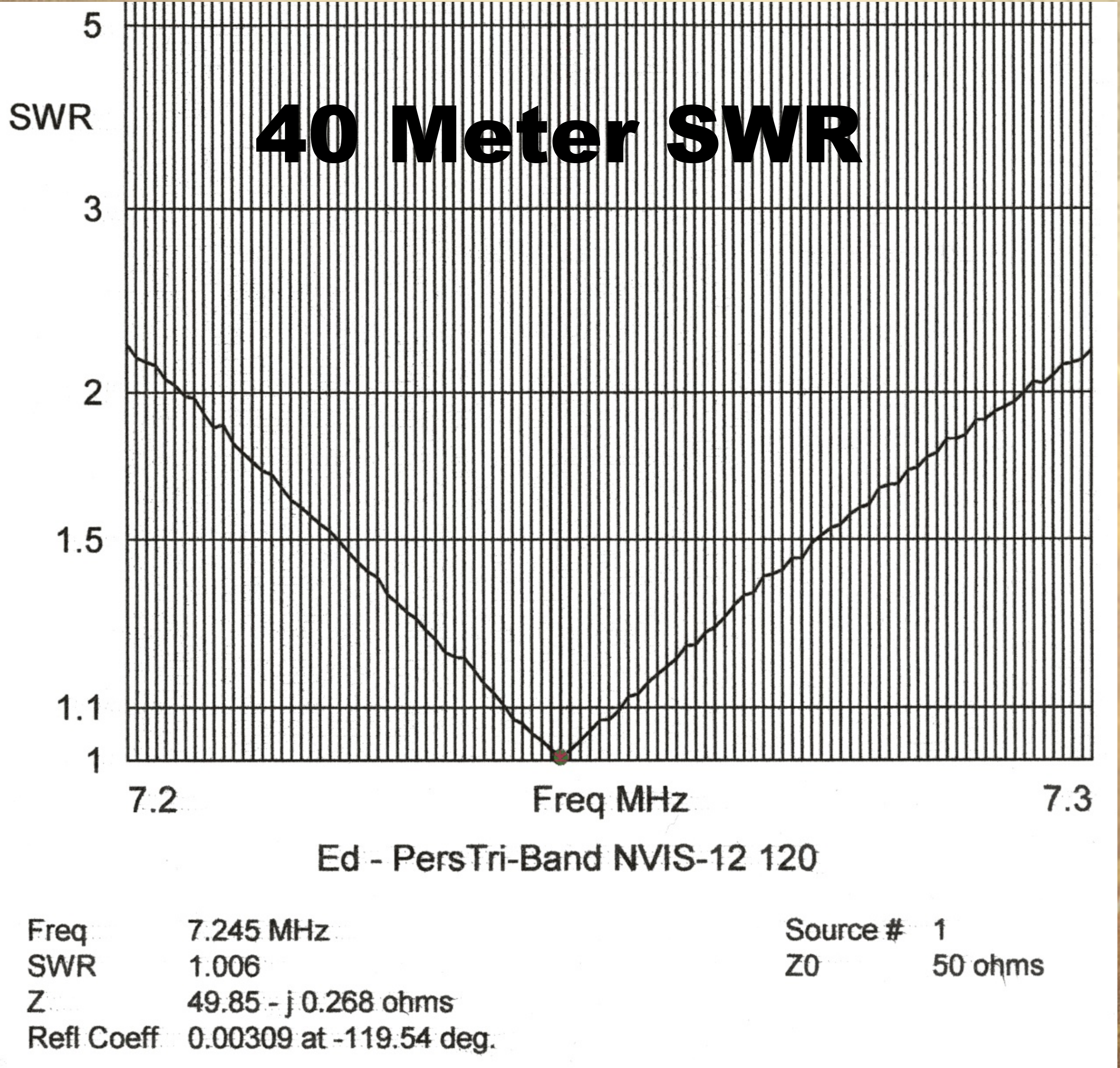
Slice Max Gain	2.08 dBi @ Elev Angle = 90.0 deg.
Beamwidth	107.0 deg.; -3dB @ 36.5, 143.5 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

60 Meter Current Distribution

EZNEC+



40 Meter SWR



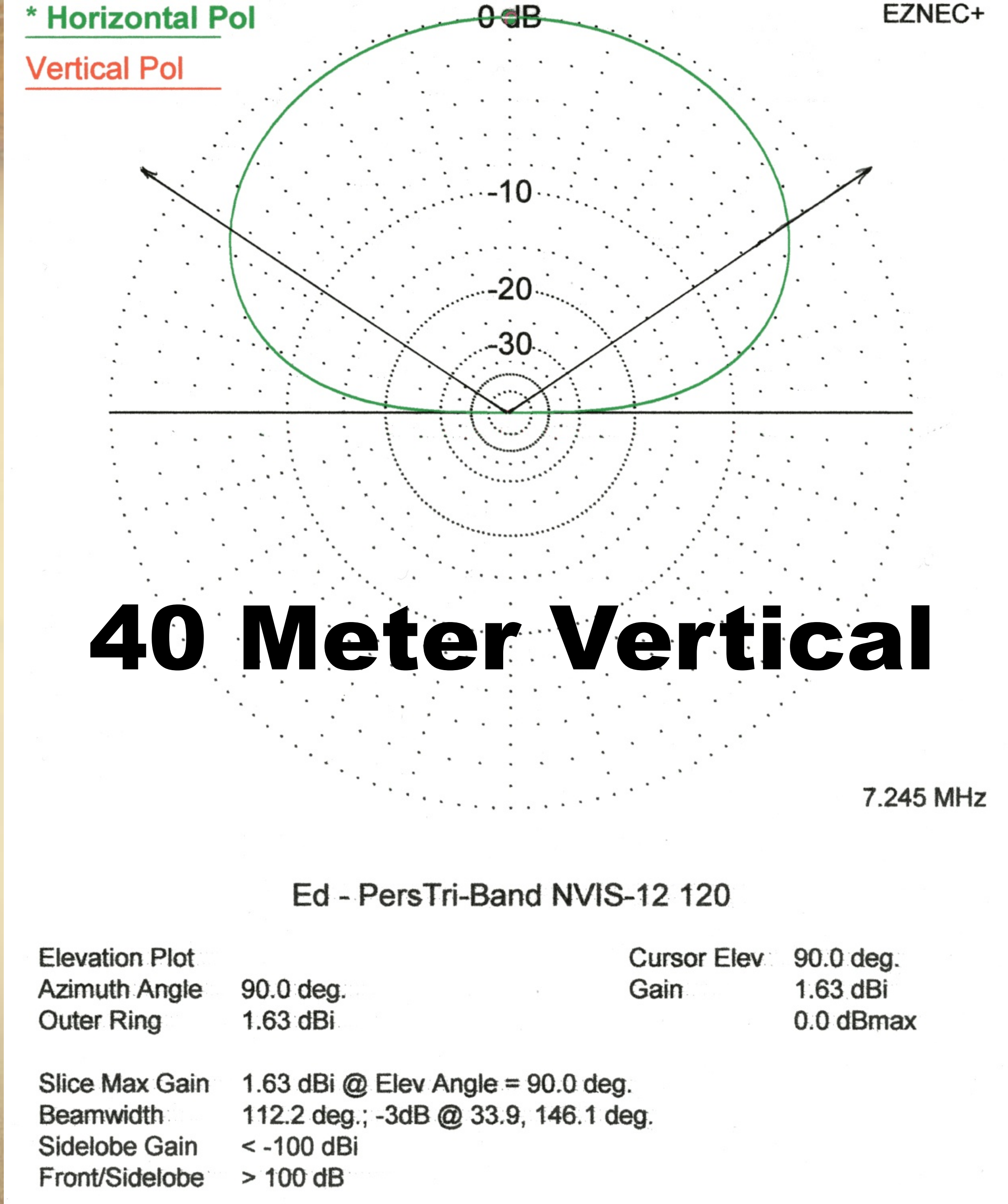
Ed - PersTri-Band NVIS-12 120

Freq	7.245 MHz	Source #	1
SWR	1.006	Z0	50 ohms
Z	49.85 - j 0.268 ohms		
Refl Coeff	0.00309 at -119.54 deg.		

Bandwidth 40 Meters

- 7295 – 1.5:1
- 7245 – dip
- 7225 – 1.5:1

40 Meter Vertical



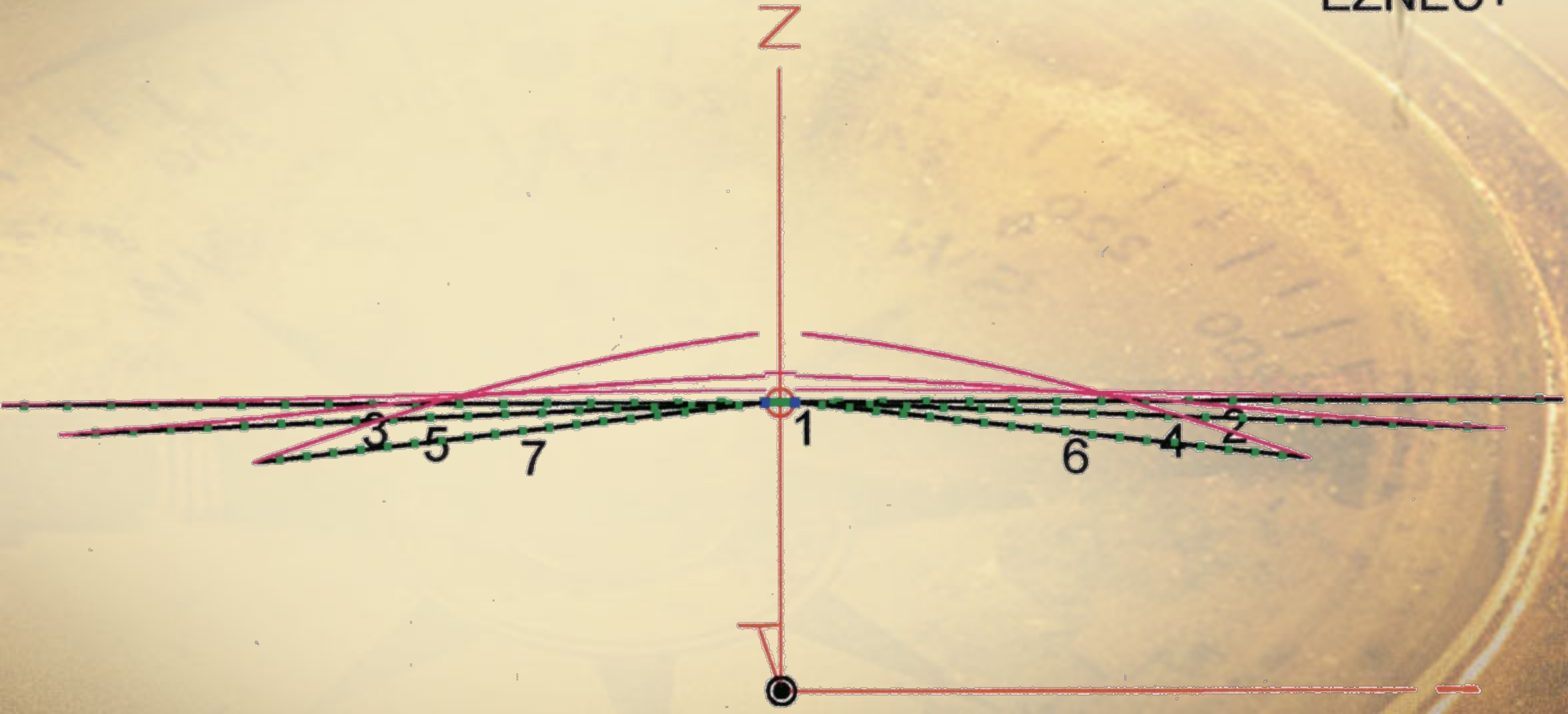
Ed - PersTri-Band NVIS-12 120

Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	90.0 deg.	Gain	1.63 dBi
Outer Ring	1.63 dBi		0.0 dBmax

Slice Max Gain	1.63 dBi @ Elev Angle = 90.0 deg.
Beamwidth	112.2 deg.; -3dB @ 33.9, 146.1 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

40 Meter Current Distribution

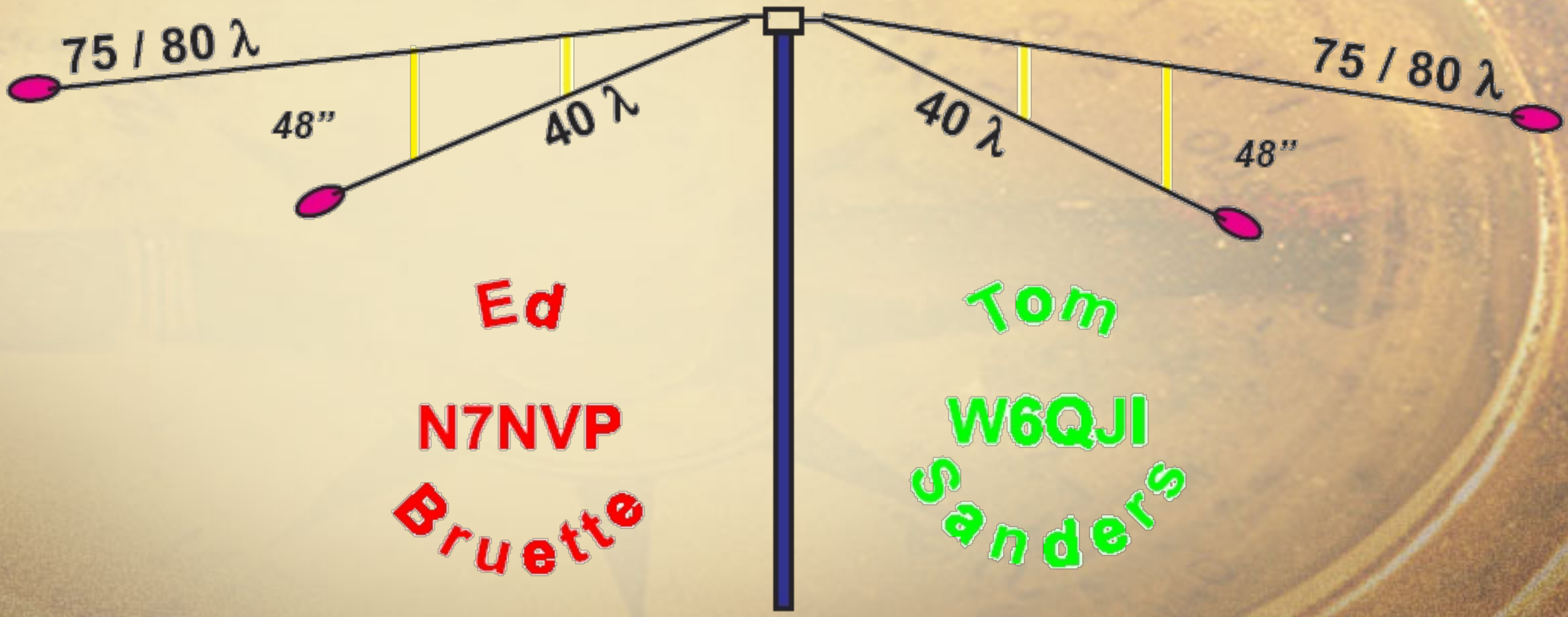
EZNEC+



Dual Band

- Yes; you can remove the 60 Meter elements!

NVIS Dual-BAND ANTENNA



Ed

N7NVP

Bruette

Tom

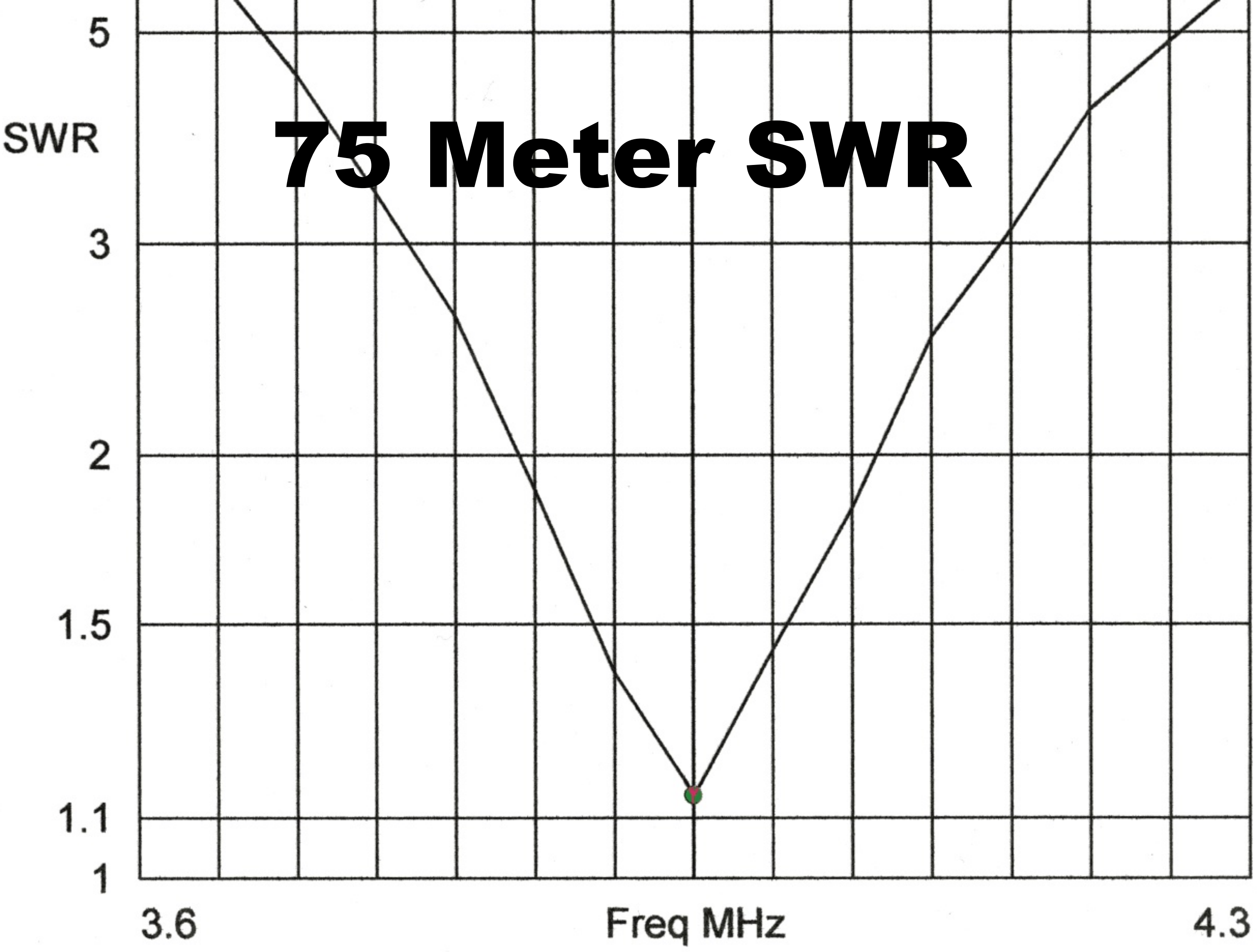
W6QJI

Sanders

Communications Academy 2005

© 2005 by Ed Bruette N7NVP [illegible]

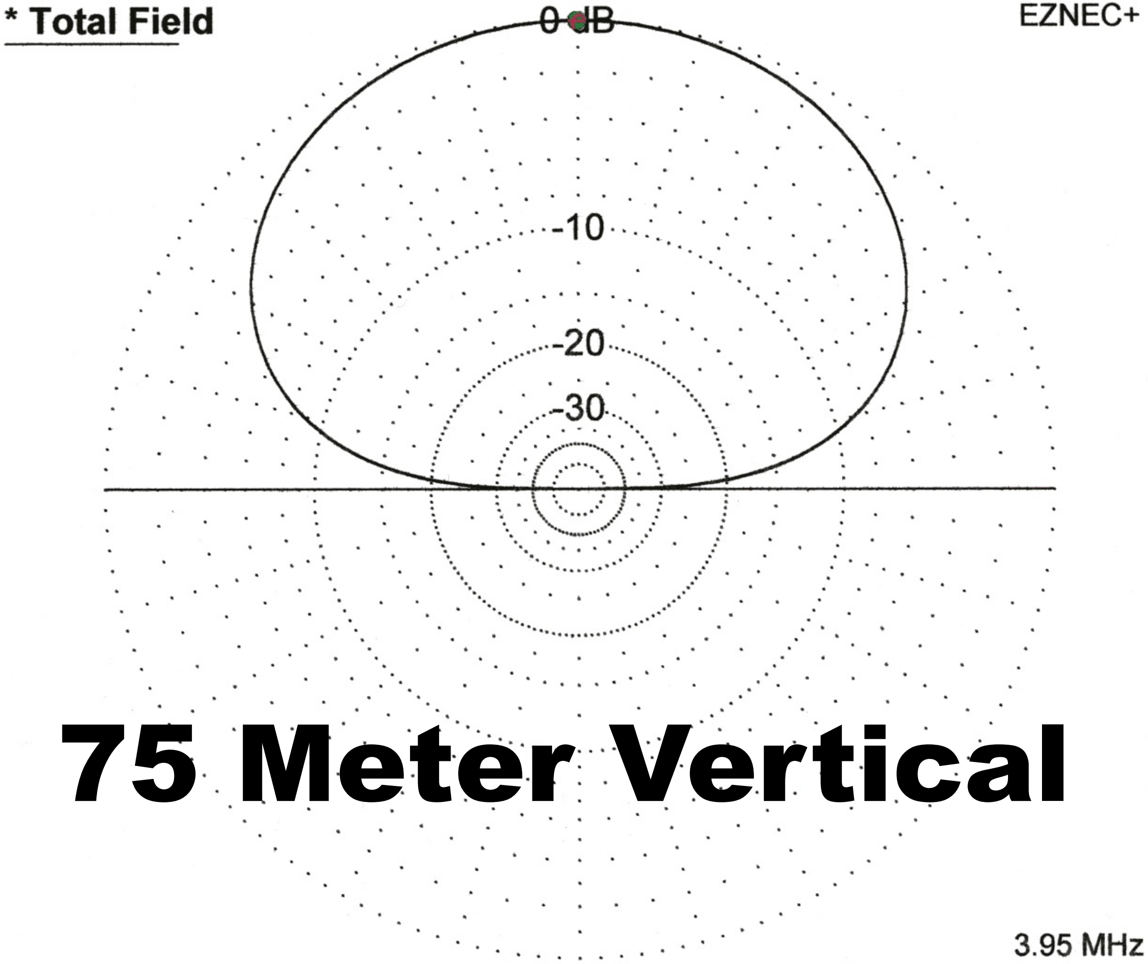
75 Meter SWR



Dual Band NVIS Without Reflect

Freq	3.95 MHz	Source #	1
SWR	1.14	Z0	50 ohms
Z	57.02 - j 0.7353 ohms		
Refl Coeff	0.06592 at -5.59 deg.		

75 Meter Vertical

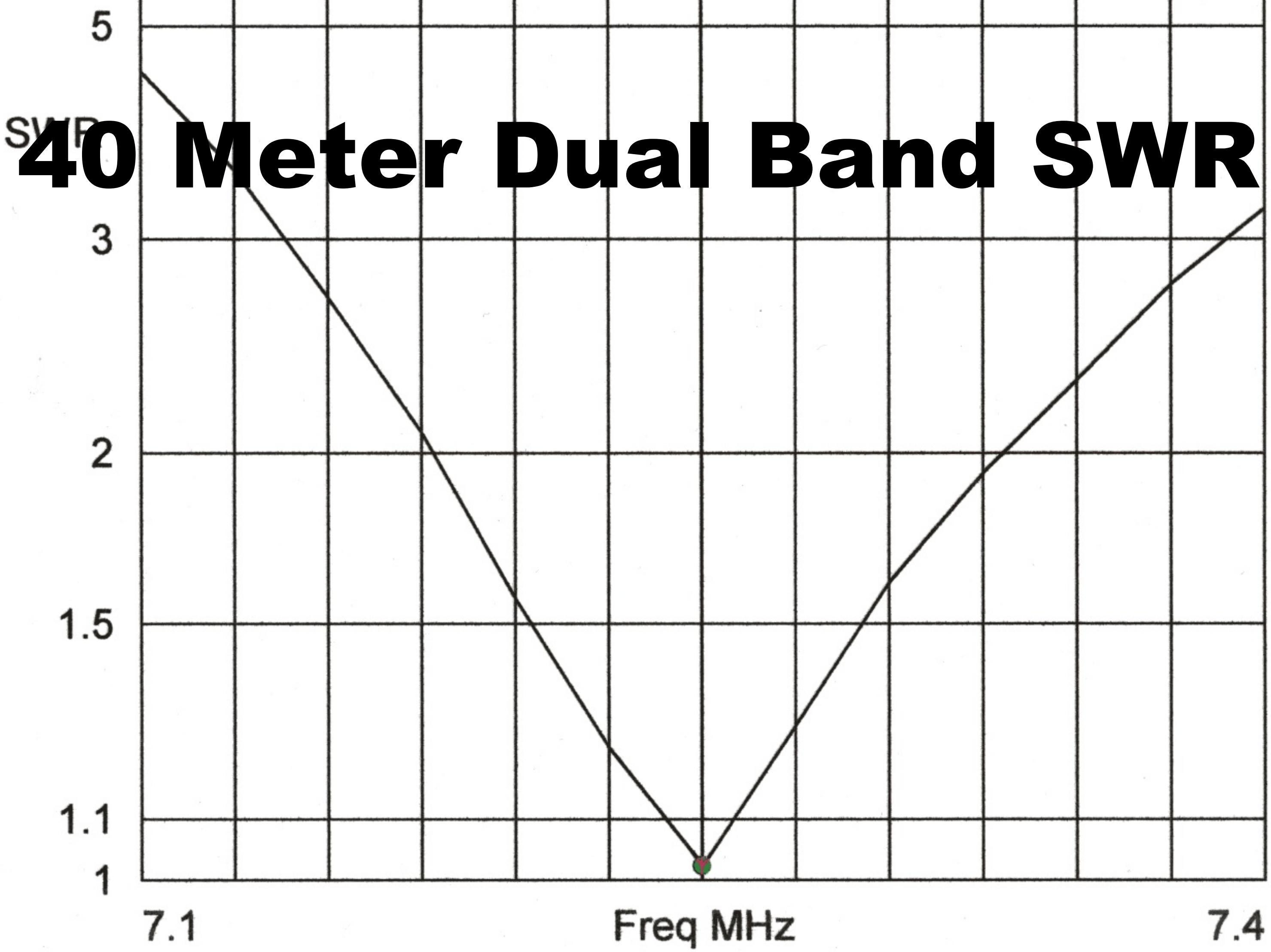


Dual Band NVIS Without Reflect

Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	90.0 deg.	Gain	3.24 dBi
Outer Ring	3.23 dBi		0.0 dBmax

Slice Max Gain	3.24 dBi @ Elev Angle = 90.0 deg.
Beamwidth	110.0 deg.; -3dB @ 35.0, 145.0 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

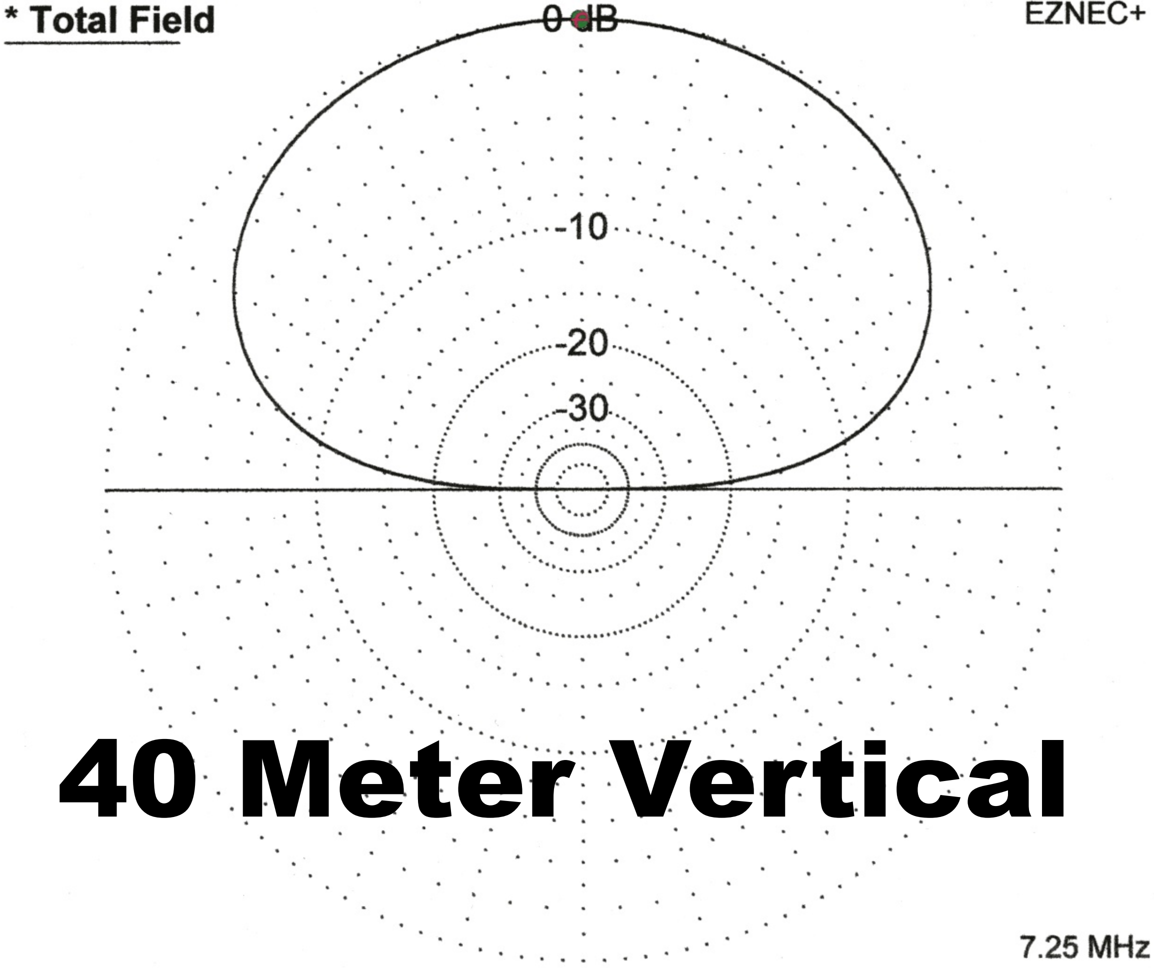
40 Meter Dual Band SWR



Dual Band NVIS Without Reflect

Freq	7.25 MHz	Source #	1
SWR	1.023	Z0	50 ohms
Z	49.81 + j 1.134 ohms		
Refl Coeff	0.01152 at 98.95 deg.		

40 Meter Vertical

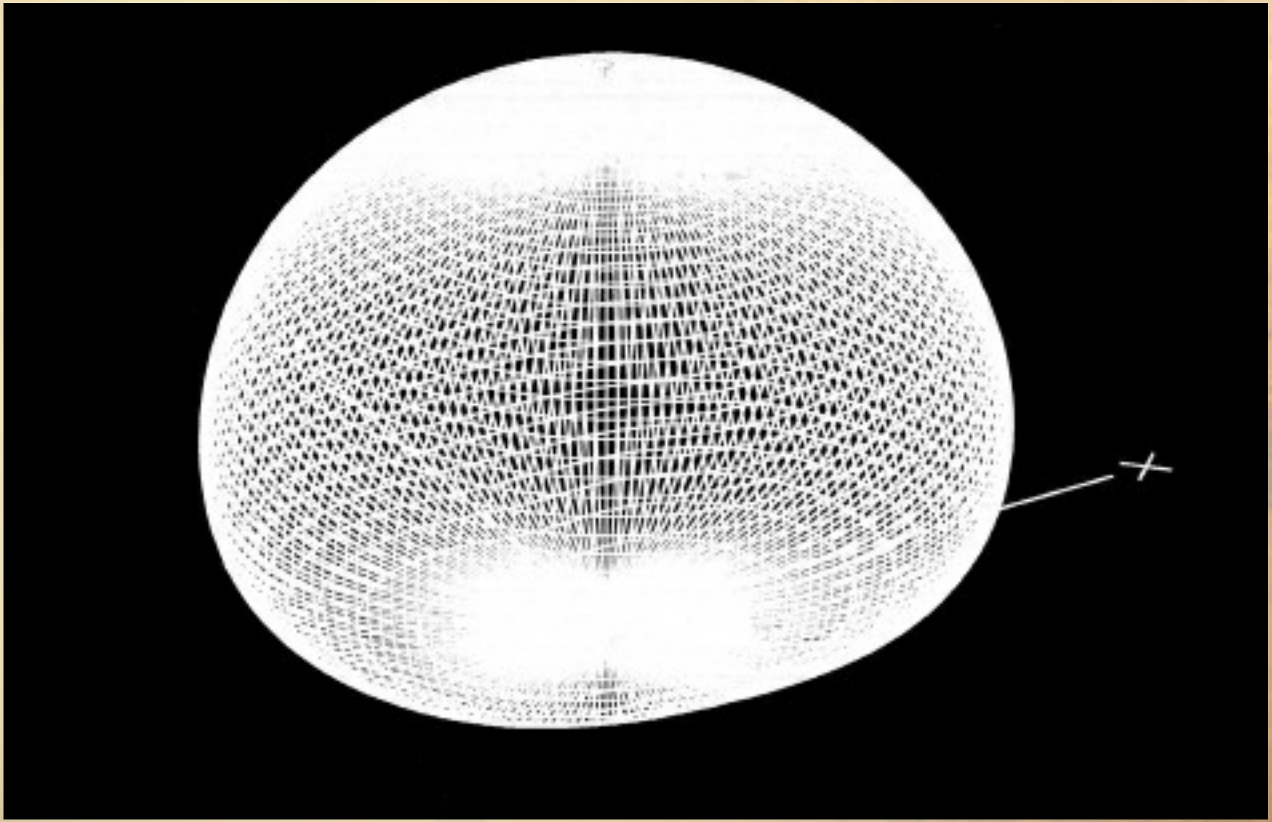


Dual Band NVIS Without Reflect

Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	90.0 deg.	Gain	2.82 dBi
Outer Ring	2.82 dBi		0.0 dBmax

Slice Max Gain	2.82 dBi @ Elev Angle = 90.0 deg.
Beamwidth	121.0 deg.; -3dB @ 29.5, 150.5 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

Omni Pattern



Depth of Current Penetration

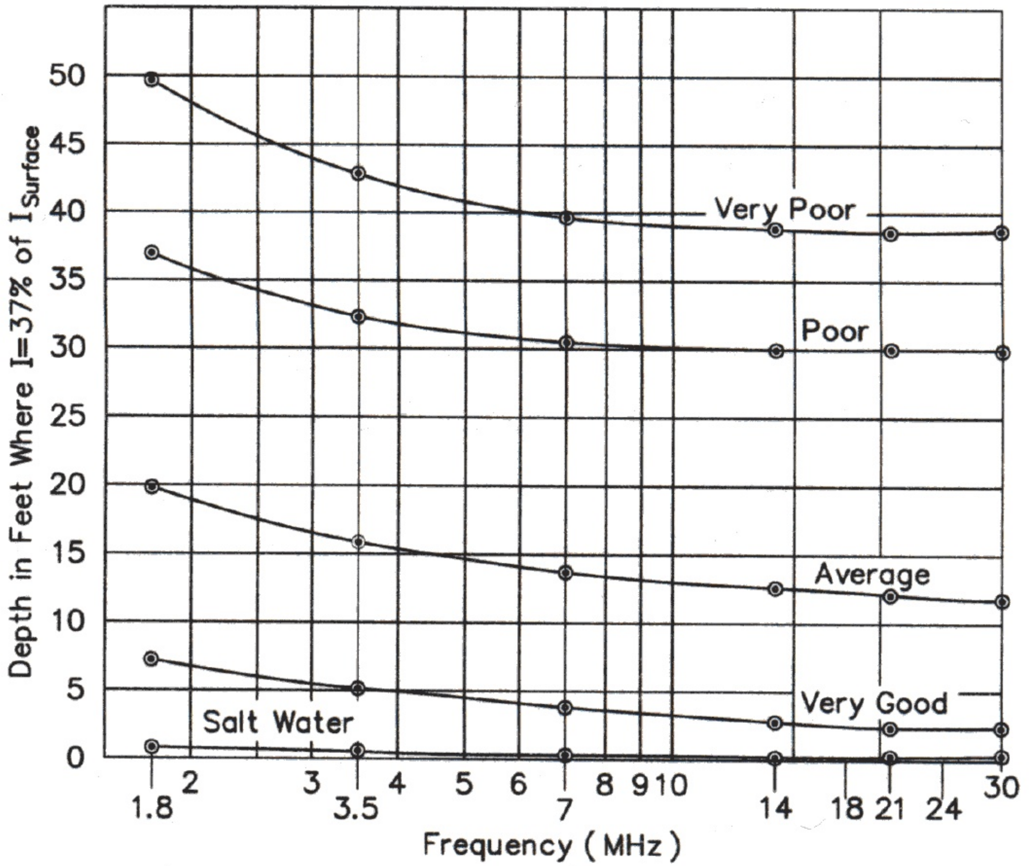


Fig 11—Depths at which the current density is 37% of that at the surface for different qualities of earth over the 1.8- to 30-MHz frequency range. The depth for fresh water, not plotted, is 156 feet and almost independent of frequency below 30 MHz. See text and Table 2 for ground constants.

Feed Point Impedance vs. Height

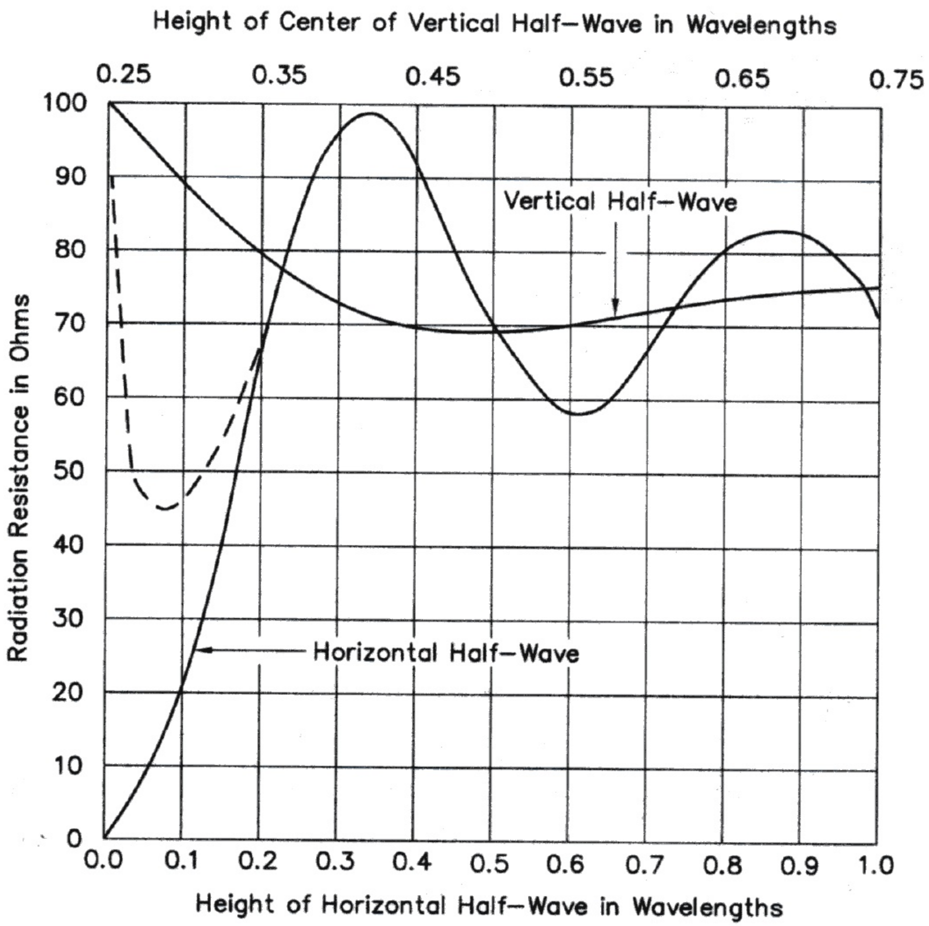


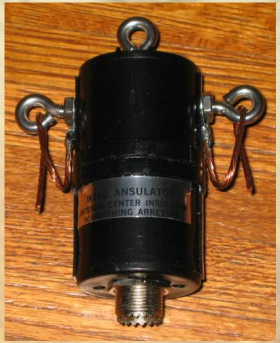
Fig 1—Variation in radiation resistance of vertical and horizontal half-wave antennas at various heights above flat ground. Solid lines are for perfectly conducting ground; the broken line is the radiation resistance of horizontal half-wave antennas at low heights over real ground.

Here’s Ed

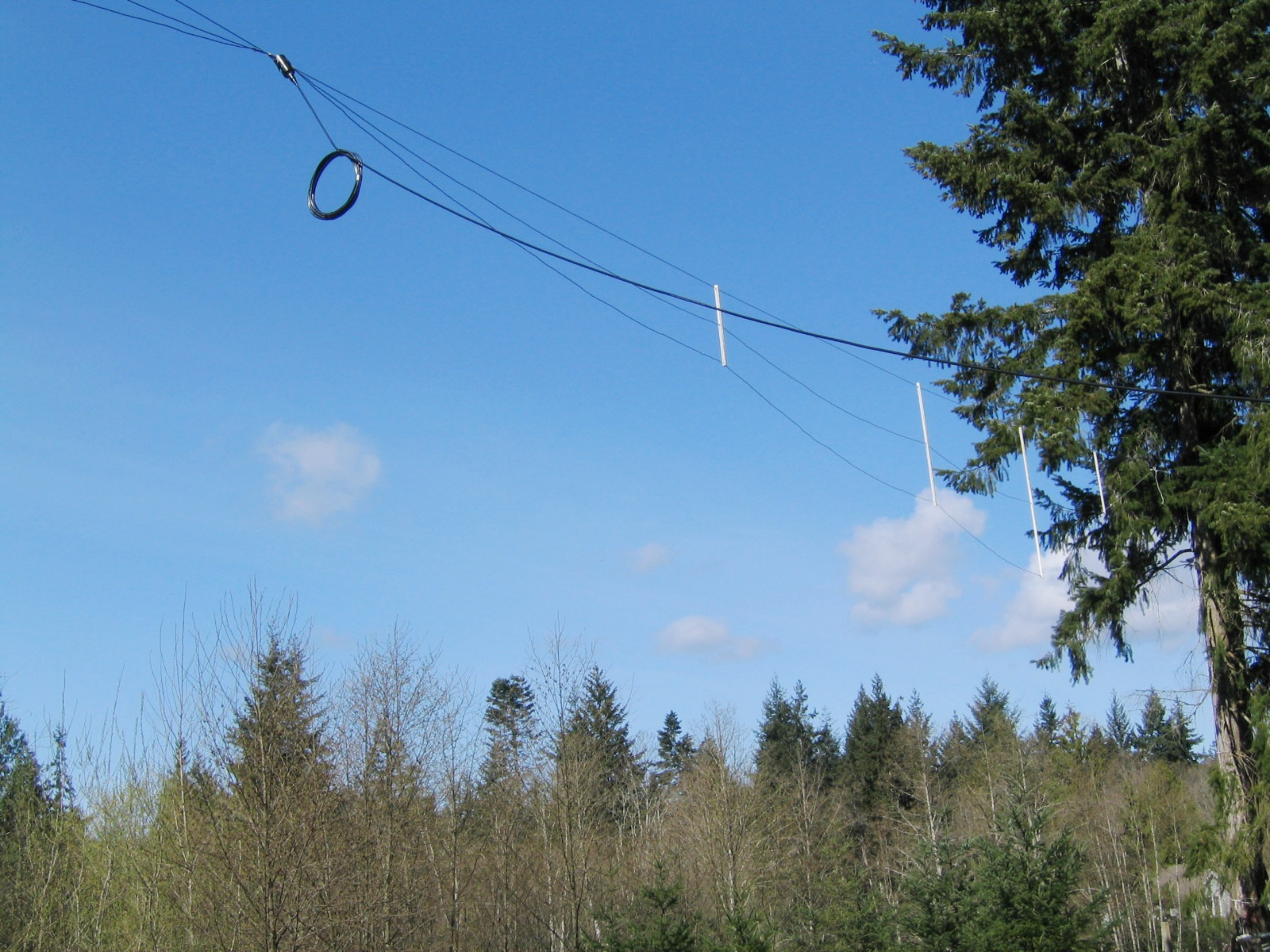
How It Went Together

- Materials
- Construction
- Modifications

Parts List



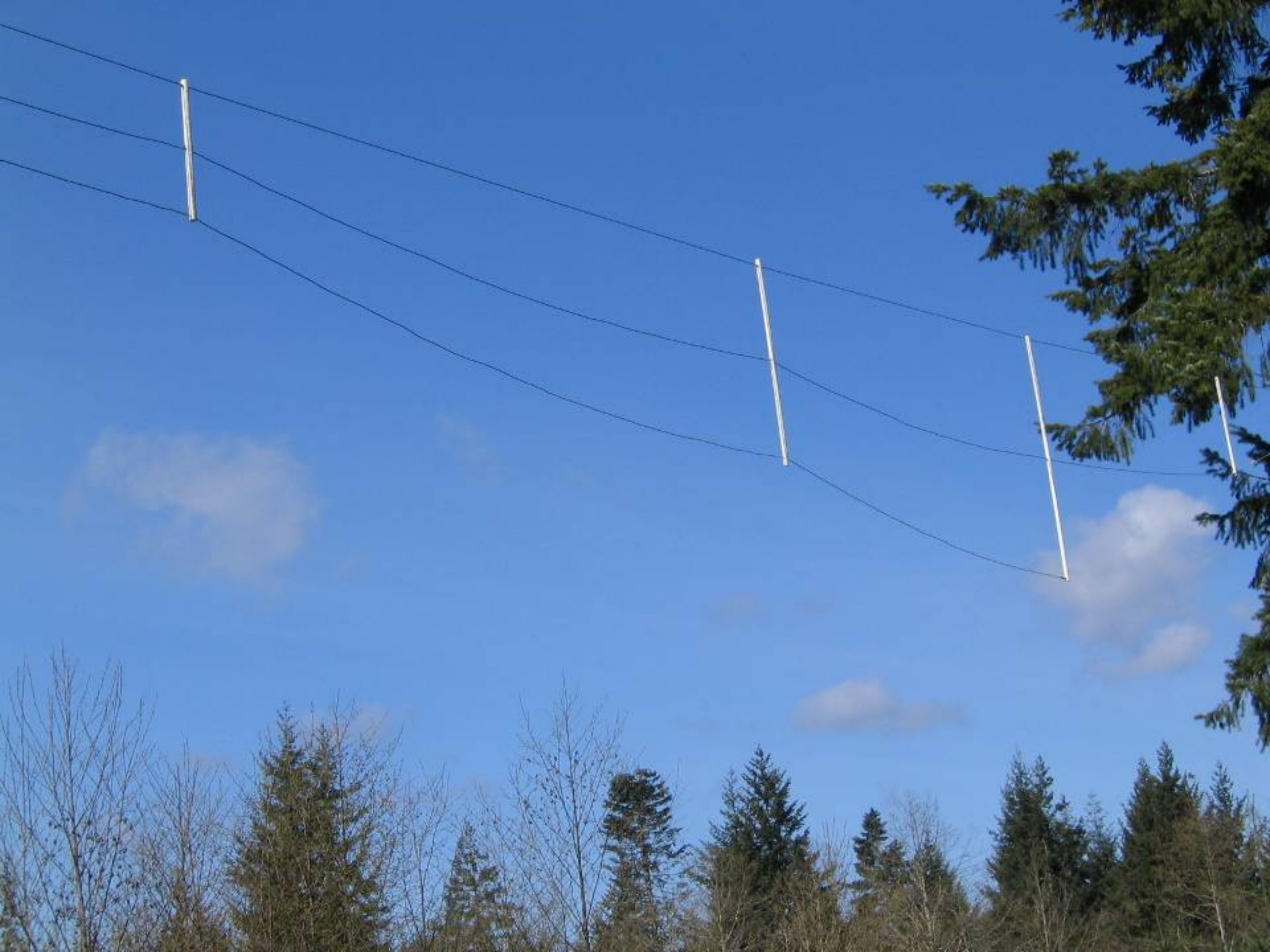
- 1 - Feed point - 50 Ohm
- #14 insulated stranded wire – 280’
- 3 - ½” x 10‘ PVC cut to length
- 2 – Insulators
- Tie wraps
- 3/16” rope cut to length
- Coax to the shack



Spreader Lengths

2 – 17”	Next to center insulator
2 – 34”	2nd from center insulator
2 – 50.5”	End of 40 M element
2 – 25.25”	End of 60M element

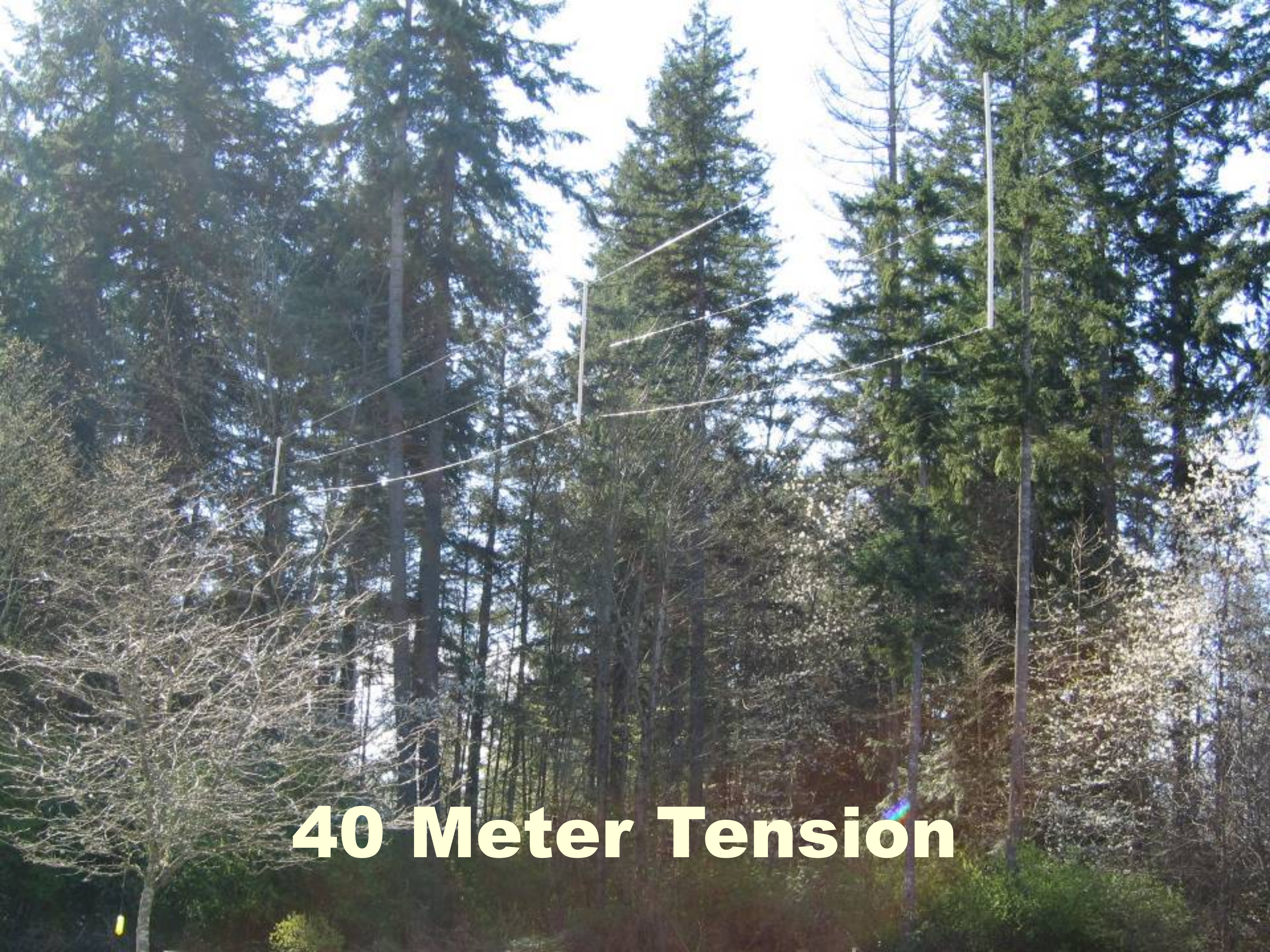
- Another spreader could be used between the center insulator and the end of the 40M element



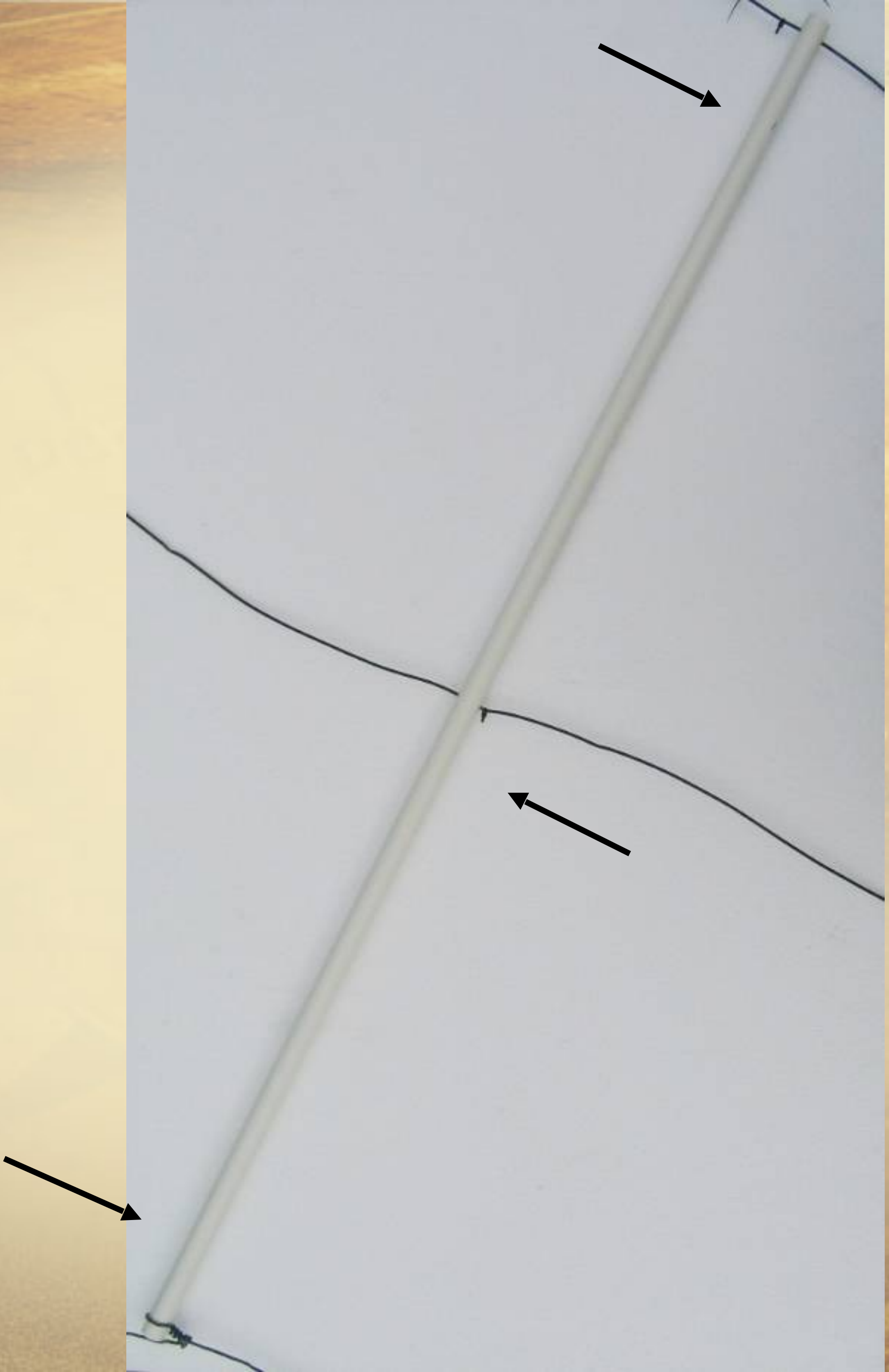
Element Lengths

- 75 Mtr legs = 57.33 ft
- 60 Mtr legs = 45.4 ft
- 40 Mtr legs = 34.25 ft

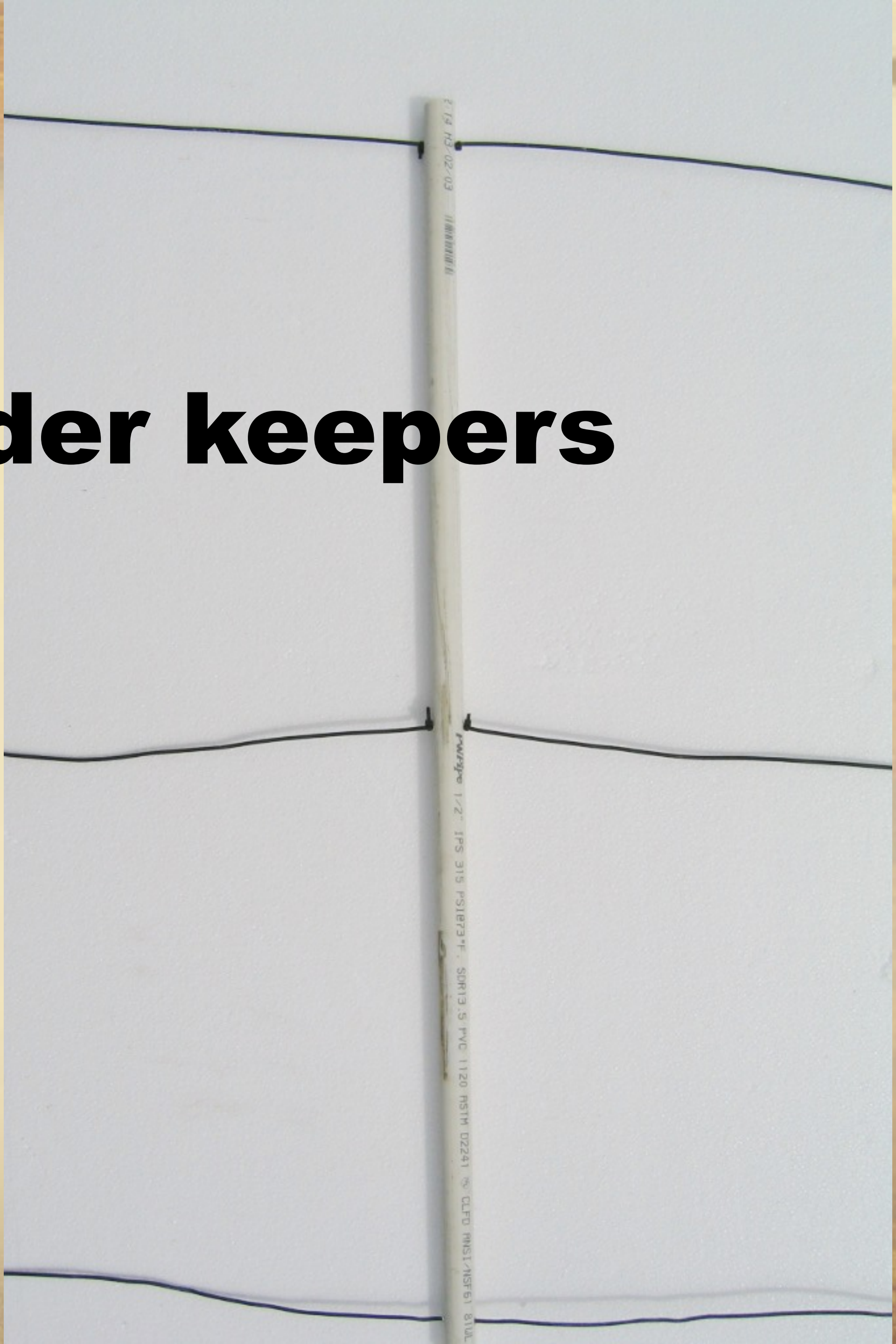
- Prune these lengths to meet your ground conditions

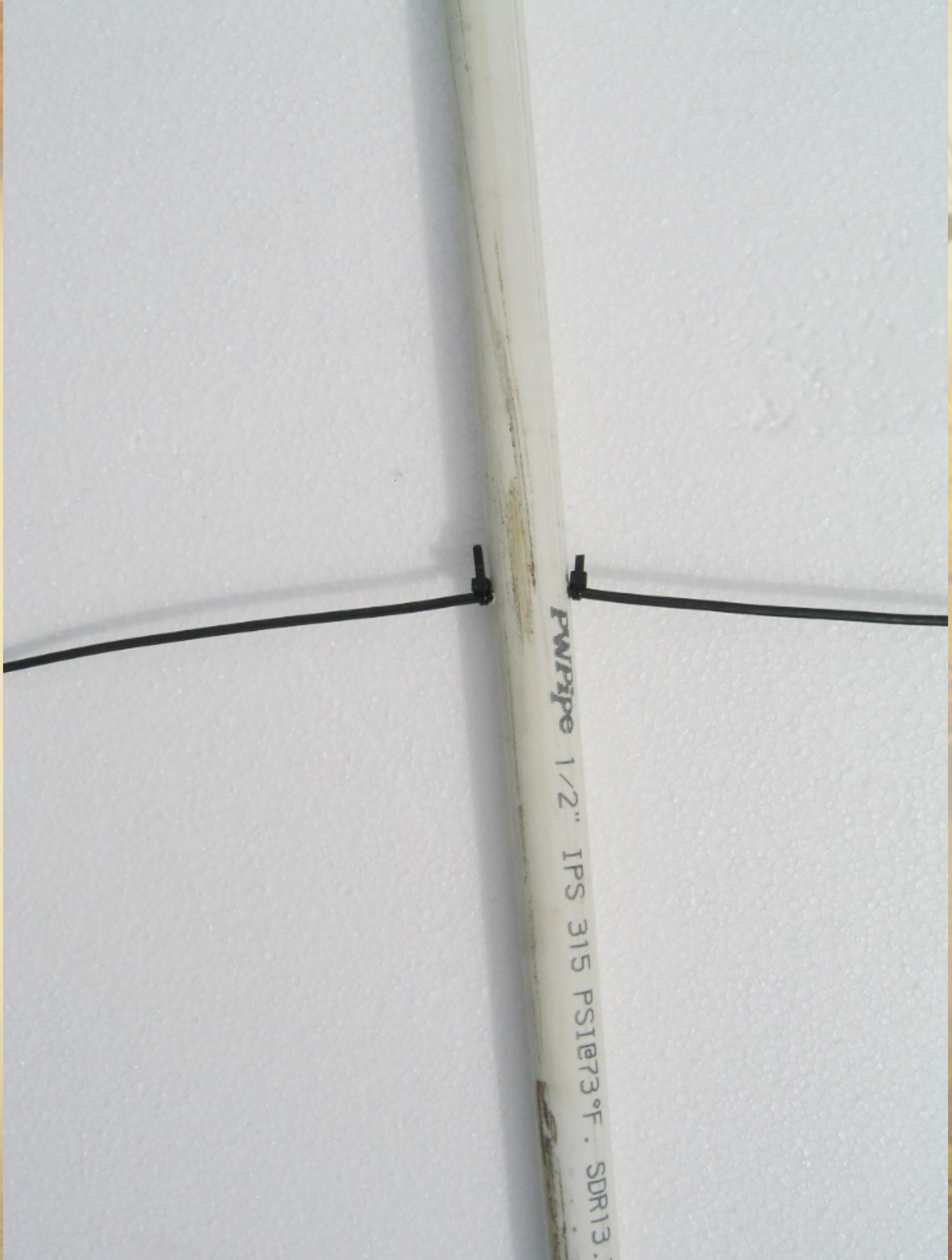


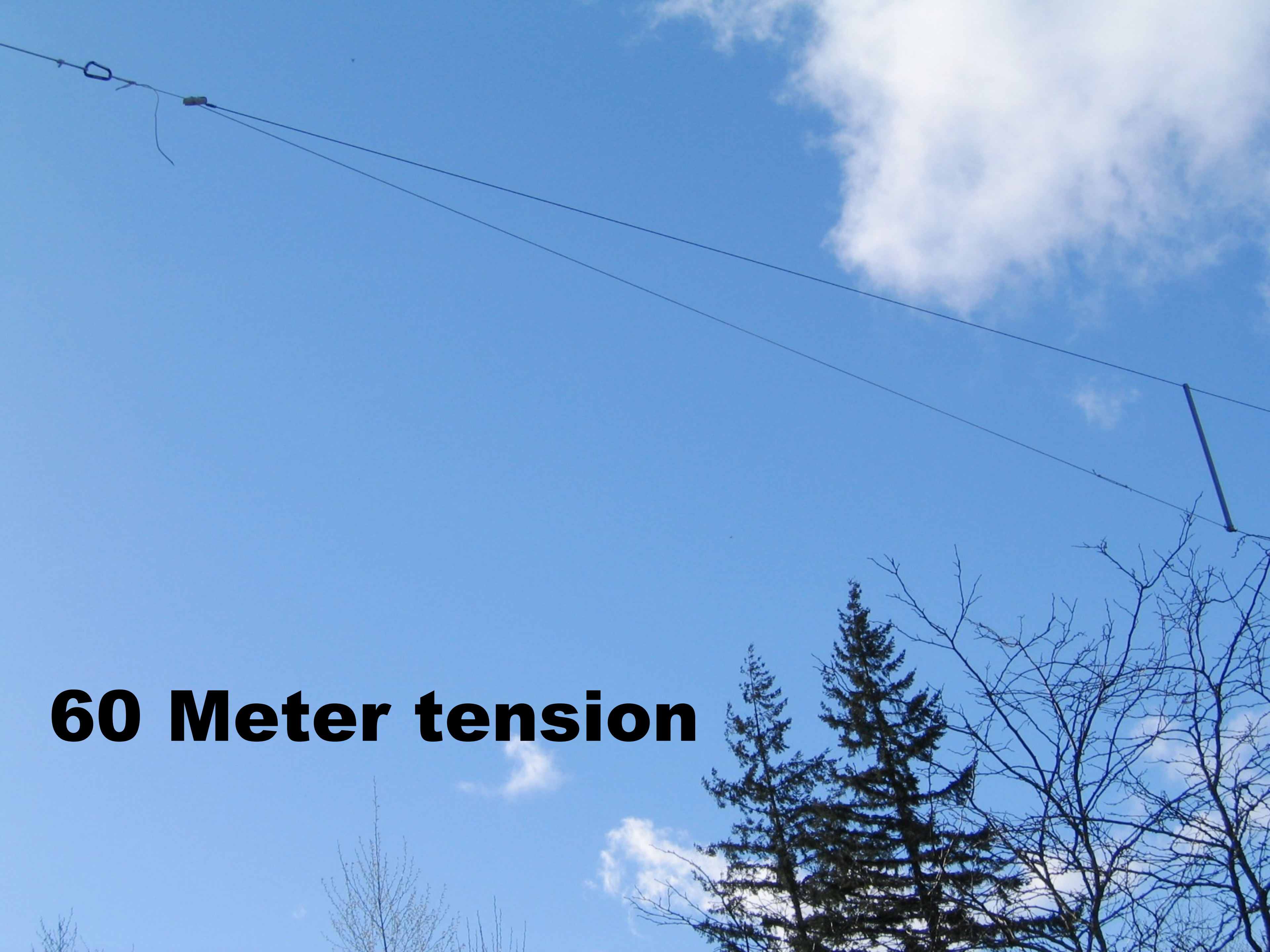
40 Meter Tension



Spreader keepers




PWPipe 1/2" IPS 315 PSI@73°F. SDR13.



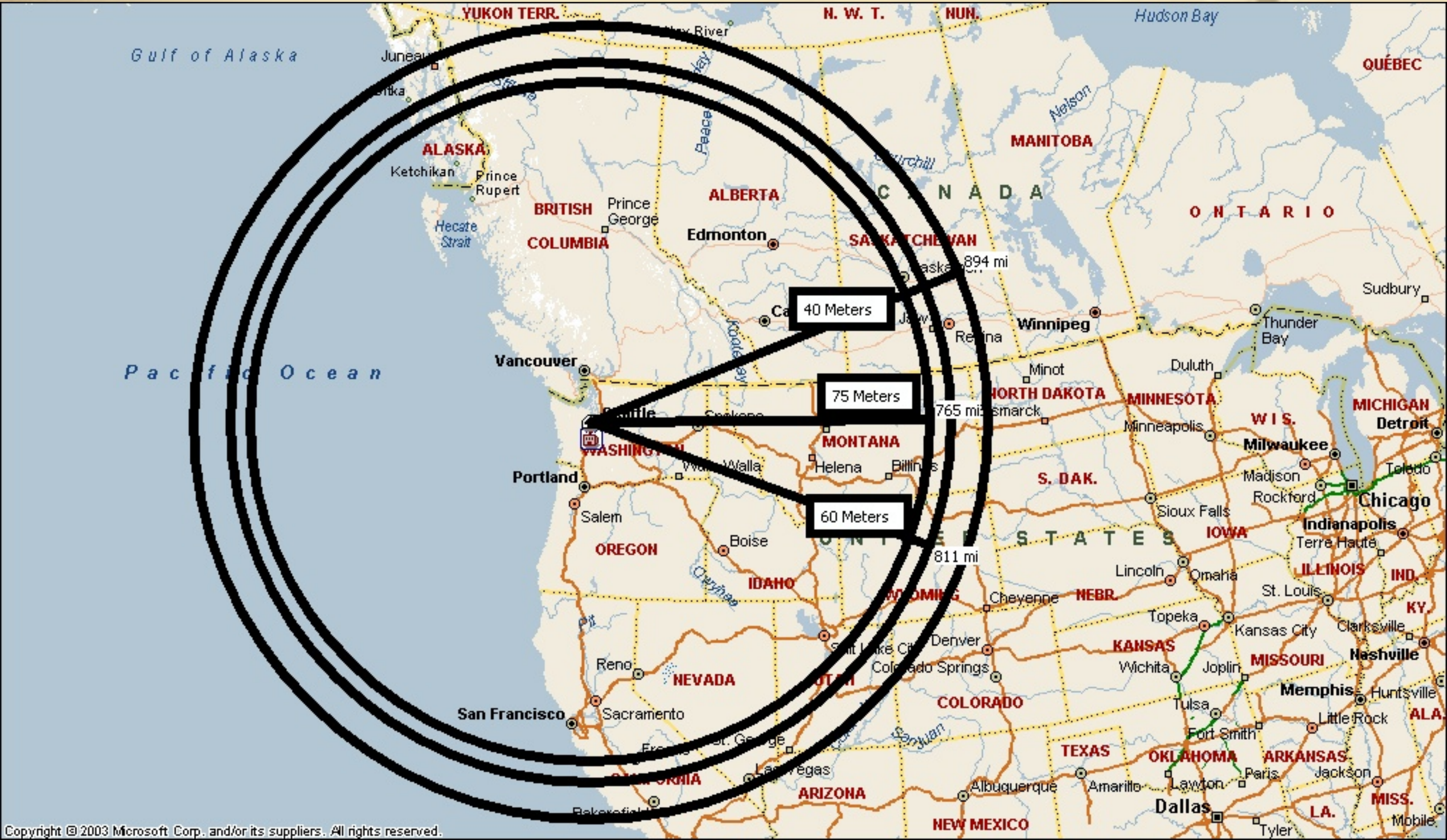
60 Meter tension

60 Meter Tension

Beamwidth

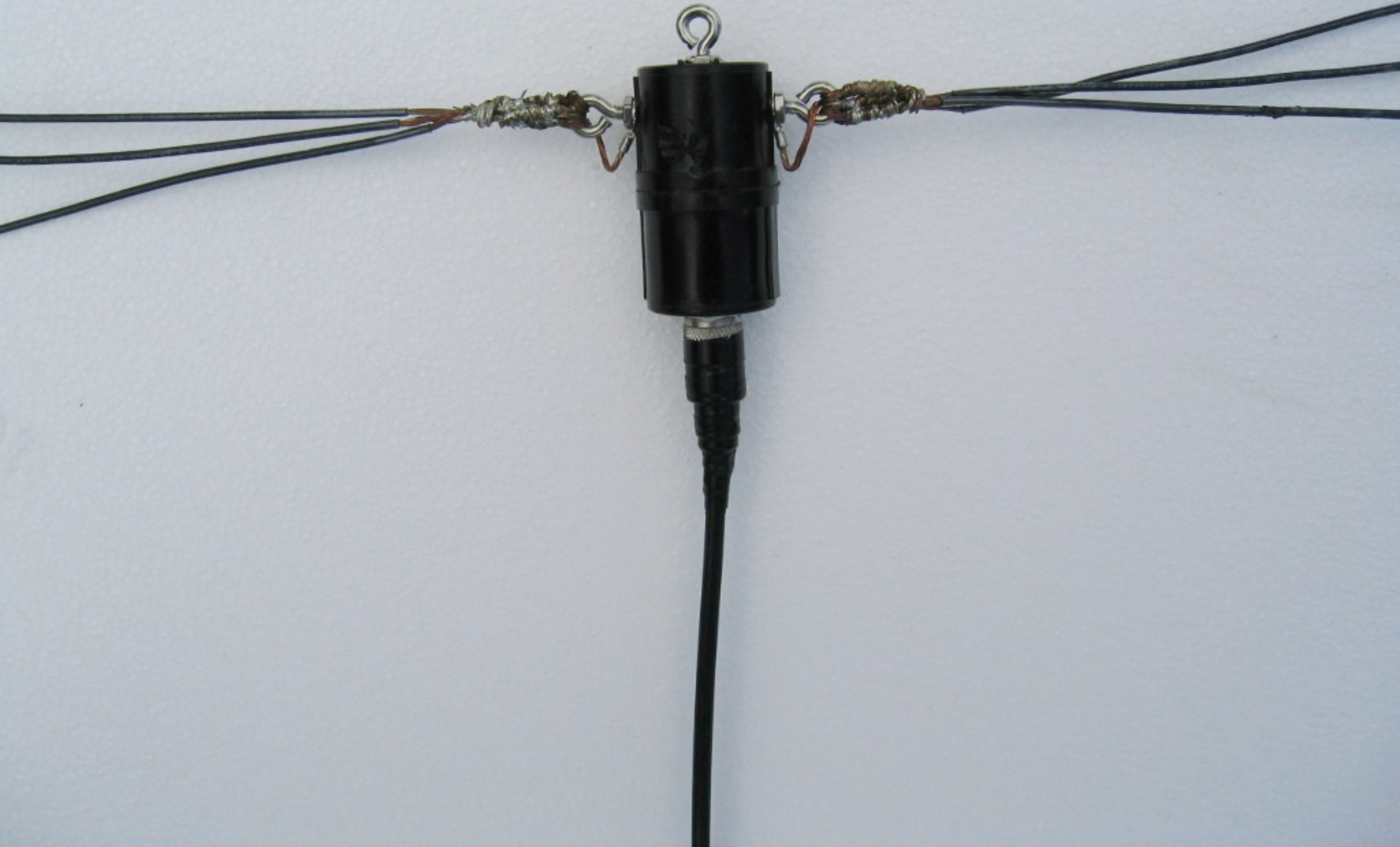
75 Mtrs	38 deg. To 142 deg.
60 Mtrs	36.5 deg To 143.5 deg.
40 Mtrs	34 deg. To 146 deg.

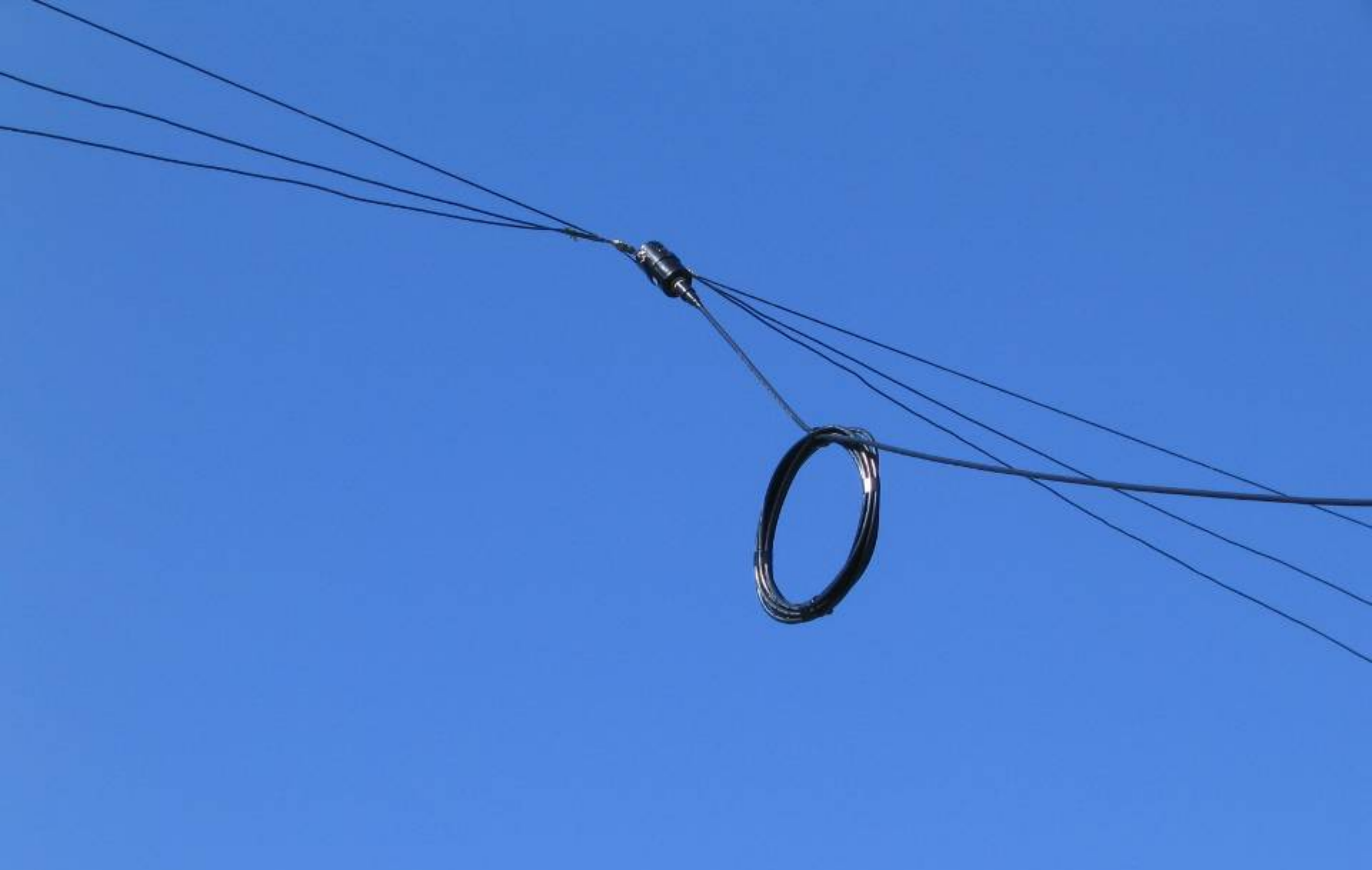
Night Time Ionosphere (300 mi.)


40 Meters
75 Meters
60 Meters
894 mi
765 mi
811 mi
Copyright © 2003 Microsoft Corp. and/or its suppliers. All rights reserved.

Hints & tips

- Solder wires at the feed point
- Solder feed point pigtail to all other wires
- Dipole insulator has an eye bolt in the top for suspension from a tree or skyhook
- Coax should be perpendicular to the antenna





Choke balun – 18’ coiled 9-10 turns

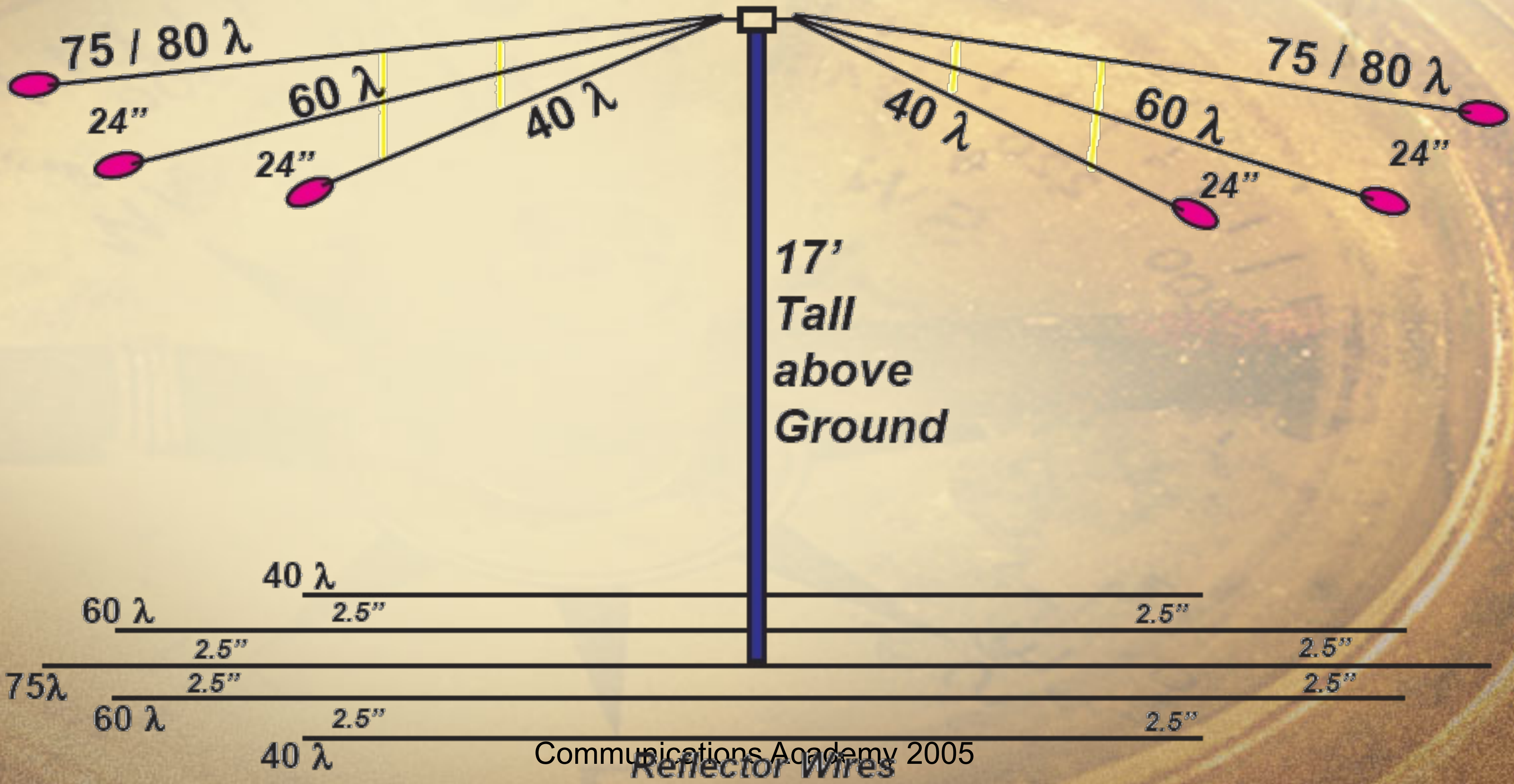
Hints & tips (cont.)

- Ground conditions will drive element lengths
- Wet vs.. dry
- Use an antenna analyzer!!!
- Tune 75M first, then 60 then 40M
- There is interaction between the 60 & 40 meter elements

Reflectors

- Ground wires laid directly under the antenna
- 5 Total!
- 1 on 75M and 2 each on 60 & 40M
- Spacing is important – 2.5”
- 60M on either side of 75M & 40M on the outside of 60M

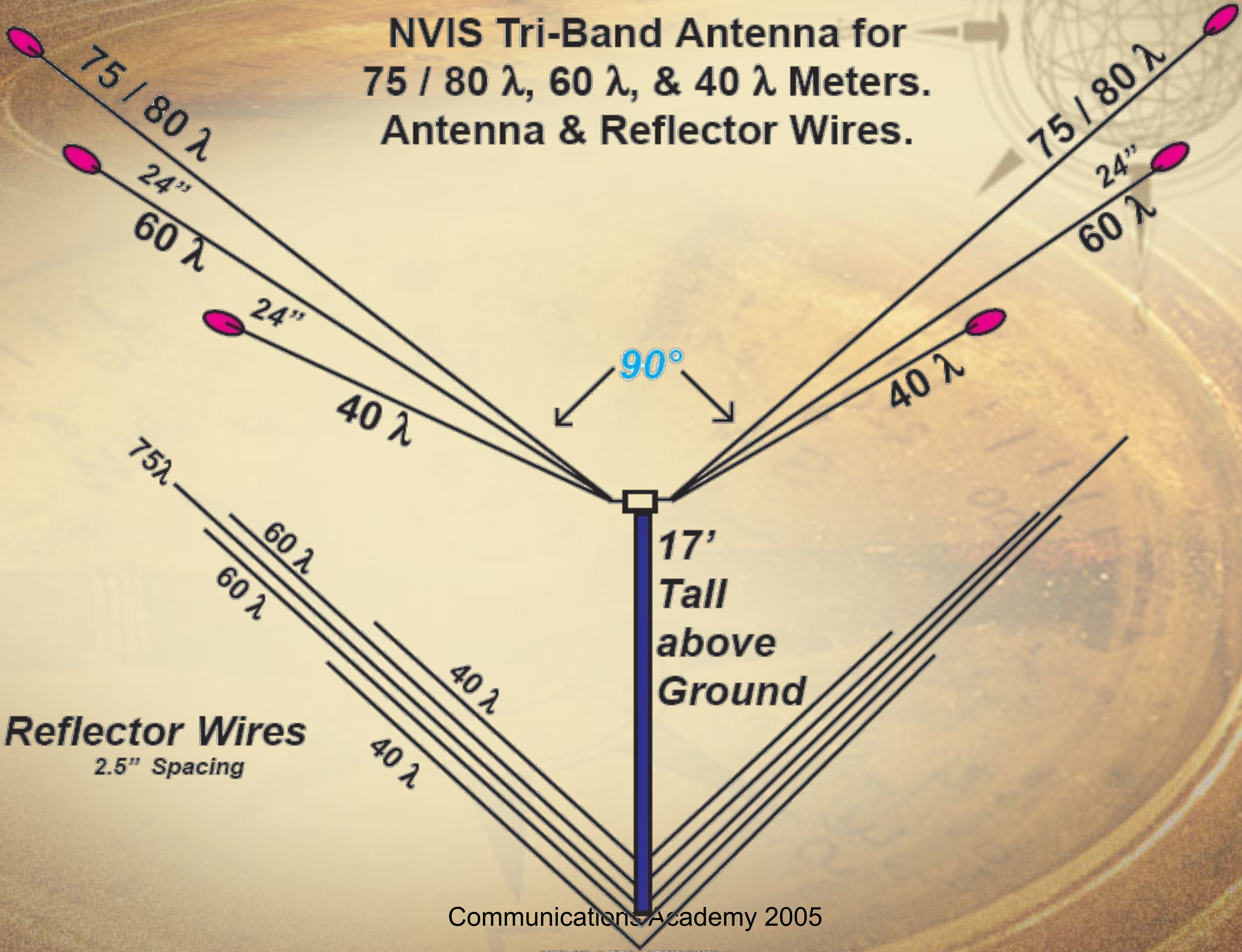
NVIS Tri-Band Antenna for 75λ / 80λ, 60λ, & 40λ Meters.
Side View with Reflector Wires



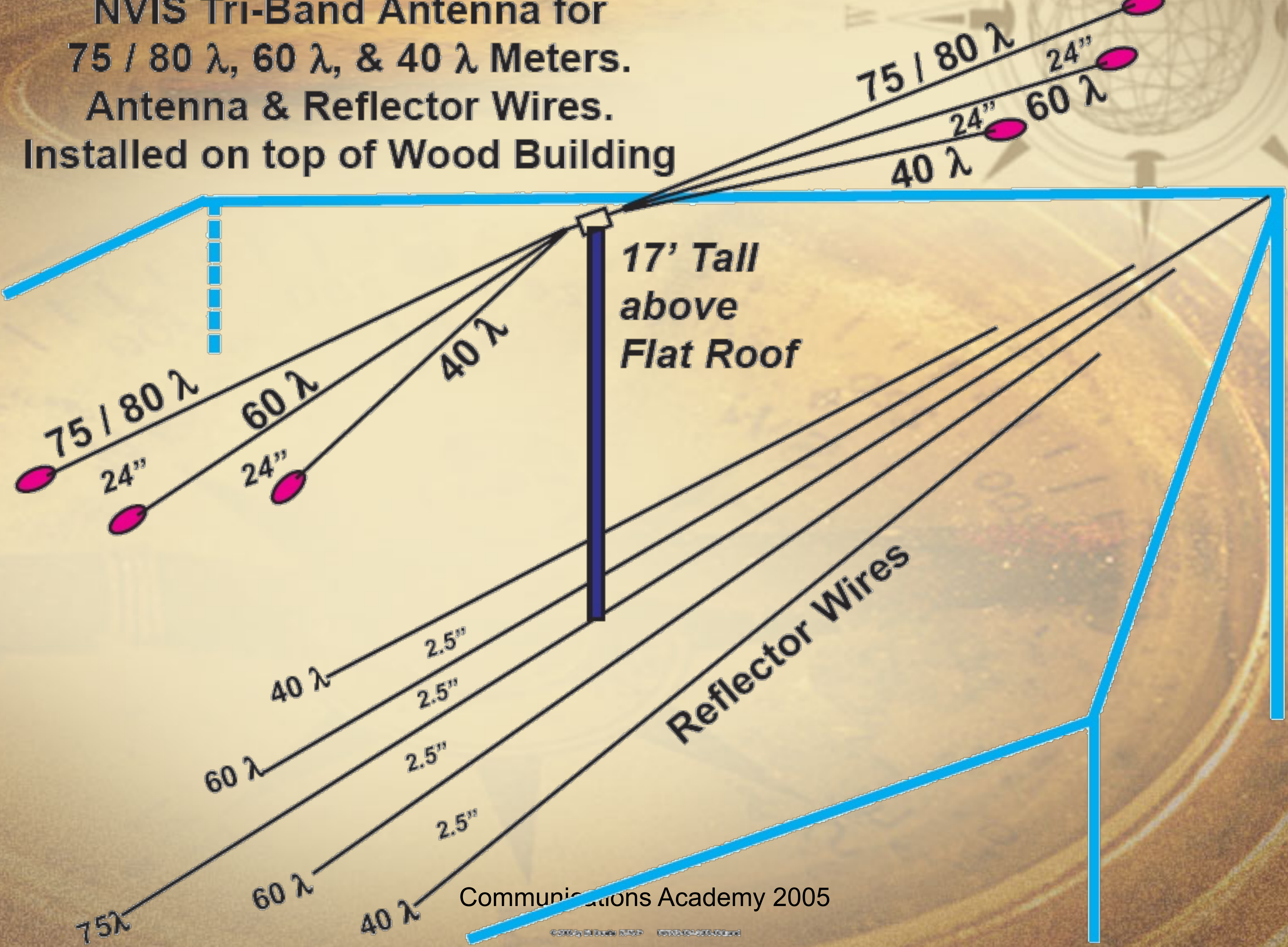
Tri-band Reflector Lengths

- 75M – 65’
- 60M – 47.9’
- 40M - 35.6’

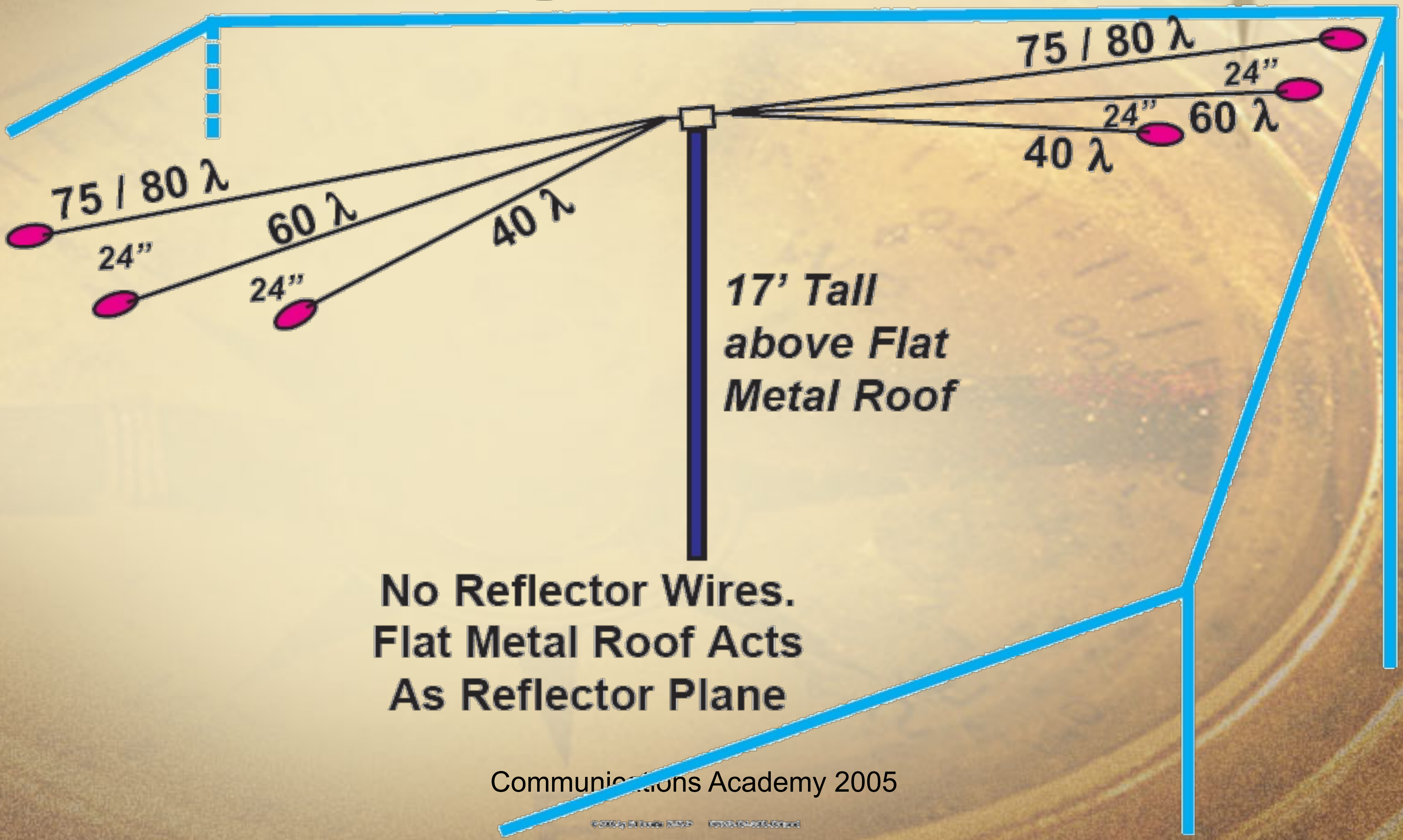
NVIS Tri-Band Antenna for 75 / 80 λ, 60 λ, & 40 λ Meters. Antenna & Reflector Wires.



NVIS Tri-Band Antenna for 75 / 80 λ, 60 λ, & 40 λ Meters. Antenna & Reflector Wires. Installed on top of Wood Building



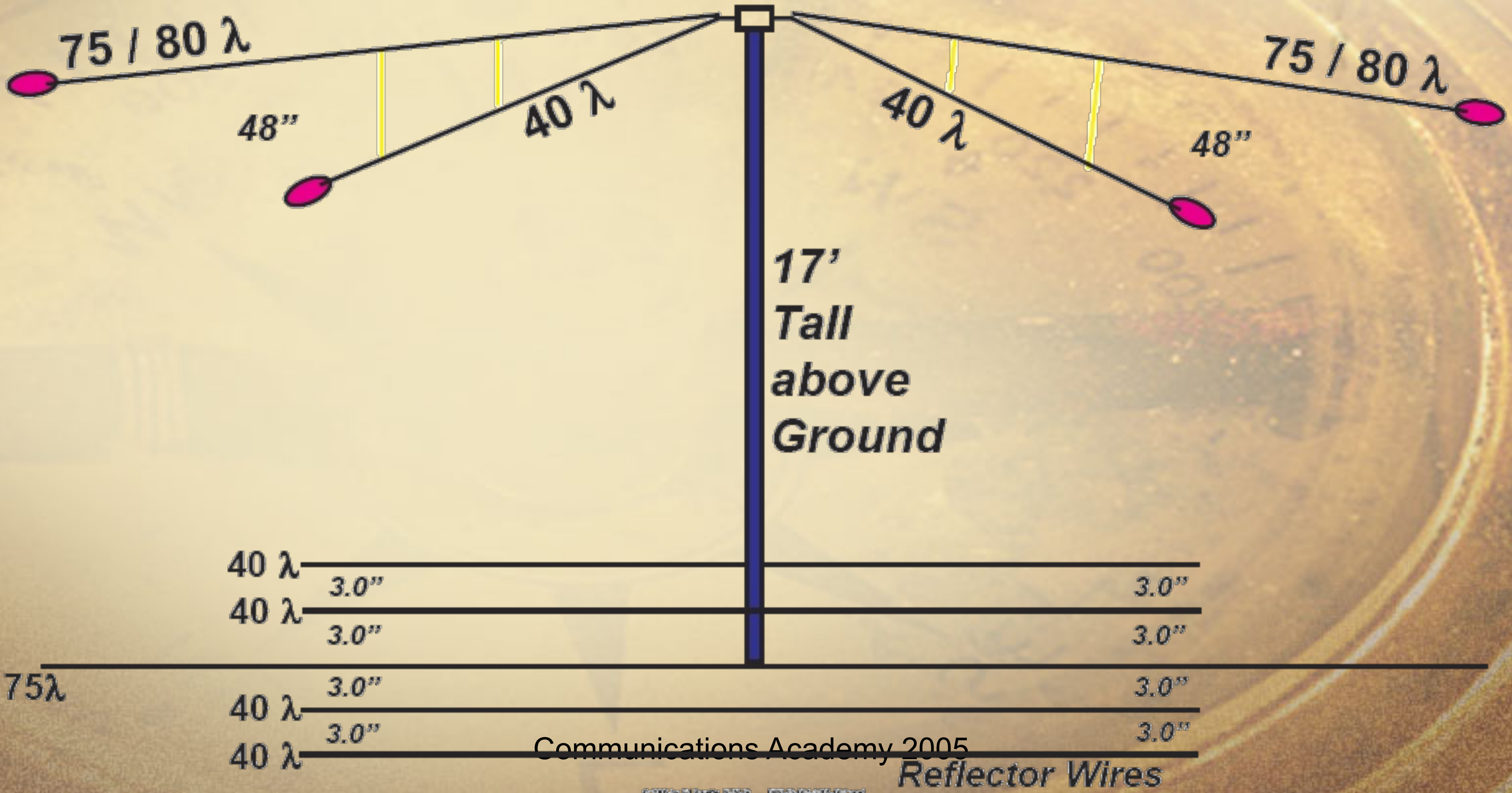
NVIS Tri-Band Antenna for 75 / 80 λ, 60 λ, & 40 λ Meters. Antenna Installed on top of Building with Metal Roof



17' Tall above Flat Metal Roof

No Reflector Wires. Flat Metal Roof Acts As Reflector Plane

NVIS Dual-Band Antenna for 75λ / 80λ, & 40λ Meters.
Side View with Reflector Wires



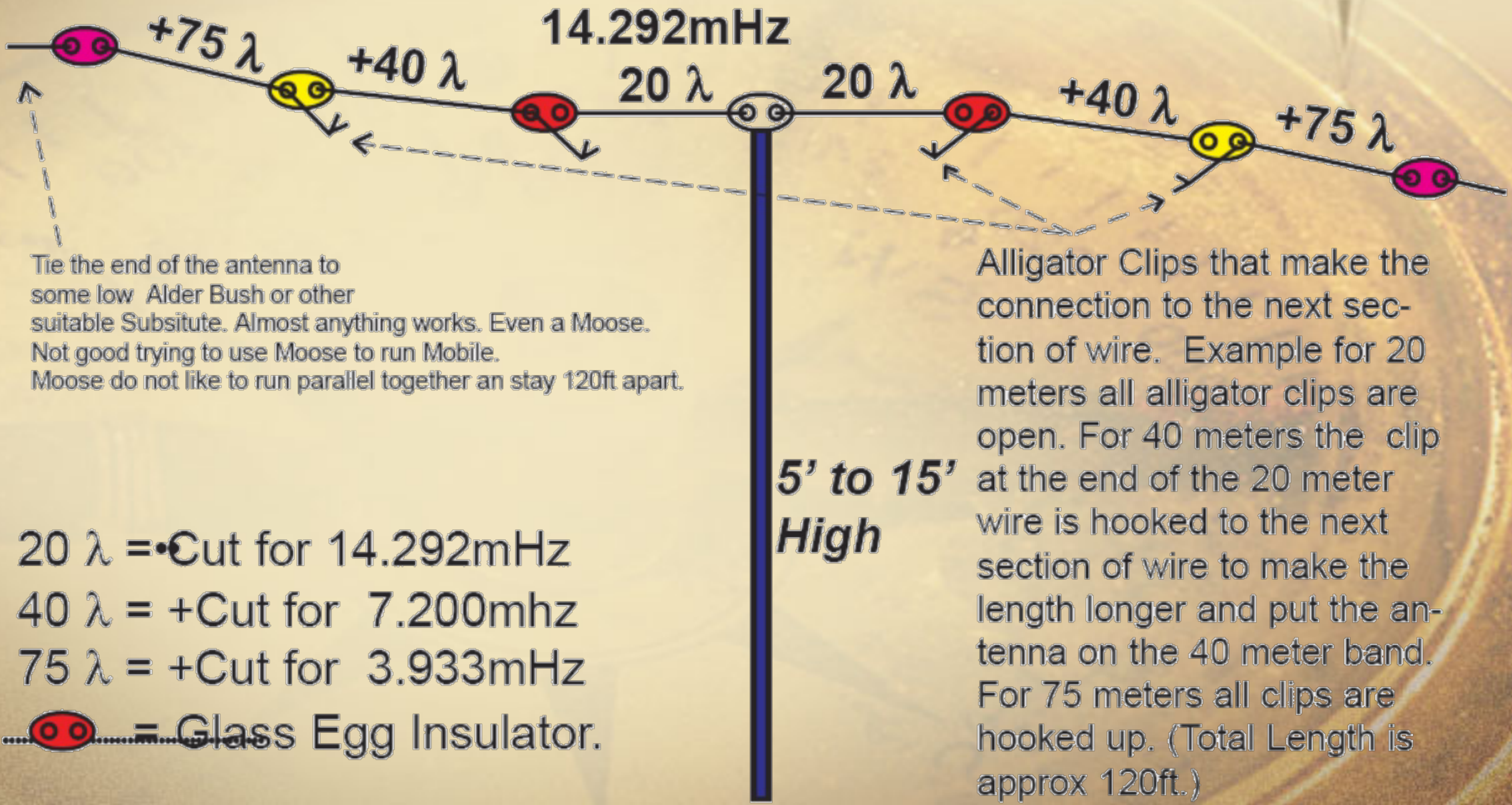
Dual Band Element Lengths

- 75 Mtr legs = 59.7 ft
- 40 Mtr legs = 35.25 ft
- Prune these lengths to meet your ground conditions

Dual Band Reflector Lengths

- 75M – 62.5’
- 40M - 37.25’

KL7AA Iditarod Tri-Band Antenna for 75λ, 40λ, & 20λ Meters.
Side View



Tie the end of the antenna to
some low Alder Bush or other
suitable Subsitute. Almost anything works. Even a Moose.
Not good trying to use Moose to run Mobile.
Moose do not like to run parallel together an stay 120ft apart.

5' to 15' High

Alligator Clips that make the connection to the next section of wire. Example for 20 meters all alligator clips are open. For 40 meters the clip at the end of the 20 meter wire is hooked to the next section of wire to make the length longer and put the antenna on the 40 meter band. For 75 meters all clips are hooked up. (Total Length is approx 120ft.)

20 λ =•Cut for 14.292mHz
40 λ = +Cut for 7.200mhz
75 λ = +Cut for 3.933mHz
⬭ = Glass Egg Insulator.

Communications Academy 2005

© 2005 by Anchorage ARC KL7AA [illegible]

60 Meter Considerations

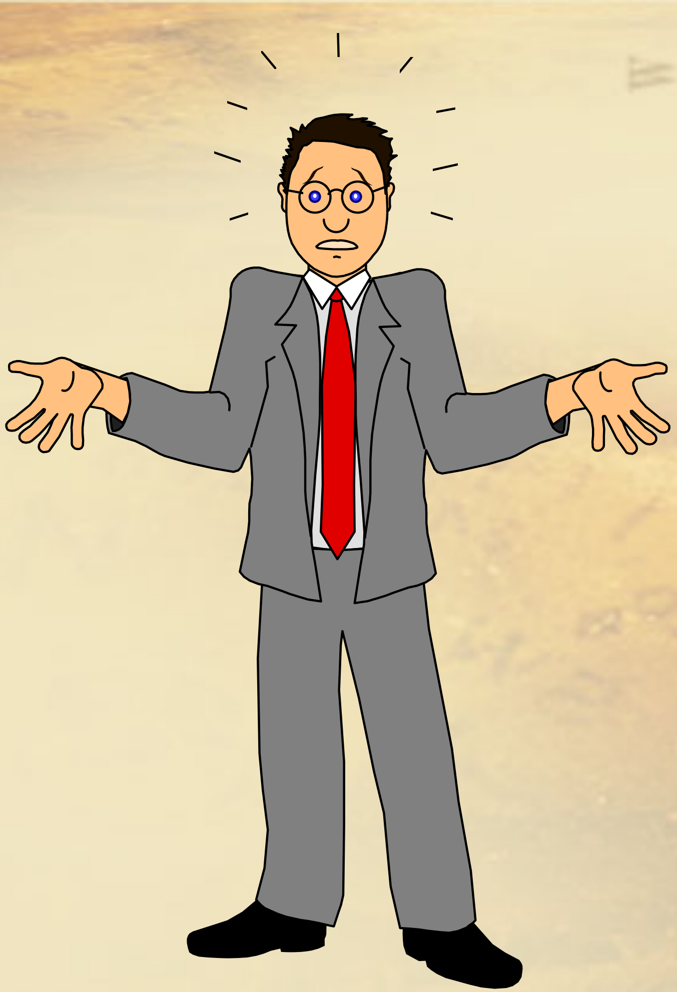
- USB
- 2.8 kHz bandwidth limitation
- 5 Channels (Window freq. -1.5 kHz)
- 50W ERP limitation
- Antenna gain
- Feedline loss
- QST Feb. 2004

Regional 60 Meter Agreement

- 5405 Nation/International
- 5373 Washington
- 5368 Idaho
- 5348 Montana/Oregon
- 5332 Regional coordination between states/sections

Thanks to Bill Balzarini, KL7BB

for all the drawings!



QUESTIONS?

Thank you!

de Ed & Tom